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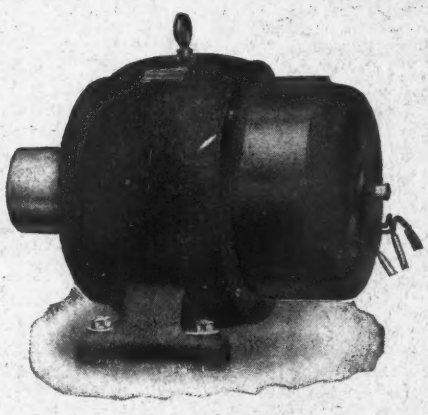

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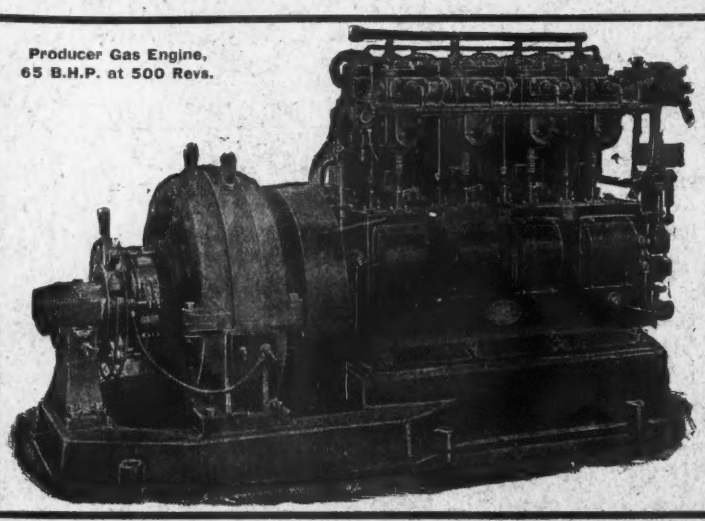

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IN view of the recent Increase in the Postal Charges, our Subscription Rates for Great Britain and Canada will until further notice be increased to £1 1s. 8d. and £1 3s. 10d. respectively.

THE VOICE OF LABOUR.

MUCH has been said and written during the last fortnight about the attitude of Labour in this great crisis of the country's history. Complaint is made that trade union leaders do not represent the real feeling of the working man upon great national questions. In particular, it is urged that the card system of voting at Trade Union Congresses is misleading. Whether this is so or not, there can be no question that organised labour has manifested an unpleasant desire to act in its own interest rather than in the interest of the country.

Individual employers in the electrical industry—to take it as an example—will tell you that they know the vast majority of their men are loyal to the core. If the works manager is a "sahib" liked and respected by the employés of the firm, they will have unburdened themselves to him "on the q.t." He knows that once they are removed from the pernicious influence of the Socialist and the demagogue these men are fully prepared to make any sacrifice that may be necessary to win the war.

But, alas! The baneful influence of the so-called trade union leader still makes itself felt! After all, this kind of man lives by agitation. He is paid to agitate. Before the war he was paid to stir up strife between Capital and Labour or between class and class, and he earned his money. Let the working man realise that it is his paramount duty to put the interests of the country before the interests of his union and before his own selfish interest, and the power of the union to do evil is gone for ever.

Some of the demagogues who are largely responsible for the present attitude of Labour in the national crisis present a forlorn spectacle at the present time. As educated men, as men who have sown their political wild oats, they have begun to realise the harm which they have done in former years. In speeches made up and down the country they denounced Capital and extolled Labour. They asserted—and their assertion was cheered to the echo—that the rich were enemies of the poor. They coined phrases which helped to win elections for the Socialist. They managed to instil these doctrines into the mind of the working man as firmly as the doctrine *Deutschland über alles* was dinned into the children of the Fatherland. And now, since the great war began, they have seen the error of their ways. Some of them have sought, and are still seeking, to undo the past. They have seen that the rich men, whom they so roundly abused, have been willing to devote life and money to the service of the King, and profess themselves surprised and pained to find that the working classes will not do the same. But the teaching of the years is not to be so lightly discarded.

In a recent special supplement the *Times* dealt at some length with education and the war. It drew instructive comparisons between the systems of education adopted by the various Powers concerned in the conflict, and laid down certain principles which ought to guide us in the future.

There is one point upon which the English and German systems are as far asunder as the poles. In Germany, the child is taught from its very earliest years to think patriotically, to feel that for a man to lay down his life for his country is the finest thing on earth. In England, on the other hand, such a principle is seldom inculcated in the elementary school.

We would essay to take up this question of education in its relation to war where the *Times* left off, and ask ourselves these questions: Did our system of education do anything to prevent the present war? Has it qualified the people to take part in the war?

As it seems to us, it were idle to limit a discussion on education to a consideration of that which takes place in elementary schools. The education of the working classes goes on long after the "highest standard" has been attained. It is continued by the demagogue and the Socialist, whose one purpose is to foster the belief that the sole object of the working man is to look after himself and his own interest. And notwithstanding that a very large number of workmen have thrown over good jobs in order to join the Colours, there is no doubt that there is a very considerable number still lagging behind. Many of these belong to a type created by the Socialist—a type which might never have been allowed to come into existence if our educational system had been framed a little more upon the German plan.

When, therefore, it is said that the voice of Labour is against this or that proposal which eminent statesmen say is necessary to win the war, it were idle to ride off on the pretence that trade union leaders are wholly without the support of their following. While it is necessary to bear this in mind, we believe that when the state of affairs at home and abroad is seen in its proper light, the working man, if dealt with personally, will not be slow to make any sacrifice which the country may demand of him.

NATIONAL BUSINESS ORGANISATION.

SHORTLY after the outbreak of war a movement was set on foot to establish an Institute of Science and Industry. Some more or less hurried preliminary measures were taken with the object of organising British industrial methods, and particularly with the view to ensuring the proper application of scientific knowledge in the production of manufactures. Perhaps there was not all the calm deliberation devoted to the project in its early days that one would have desired. There was a preliminary luncheon; a preliminary scheme was drawn up in which the founding of a new trade journal better than all others formed an important part; a number of free articles were offered to the Press; a meeting was called at the Mansion House but the original time had to be altered, and other scientific conferences held on the same day clashed with the event, so that the audience was very limited; the name of the Institute underwent a change, and the details of the scheme also underwent alteration. On April 9th, 1915, we stated in these pages that for many years we had all been talking about the necessity for closer co-operation between science, industry and finance, and that the time had surely come for something in the way of action. Hardly was the ink dry when we received a communication from the Institute of Industry and Science which led us to hope for some definite action to be taken and its nature disclosed at a dinner which was to be given "in about a month's time to the leading industrialists, scientists, and bankers." Deliberation was no longer wanting. Since that date we have endeavoured to possess our souls in patience, but the announcement, like so much else, was very hurried, and we have had to wait nine months. That may not matter very much under the circumstances, but it would have mattered very much indeed if we had had to wait for it in order that the nation might have made any progress toward securing that greater scientific and industrial co-operation that we have all been so eager to ensure. At the end of nine months we are entertained to luncheon at the Savoy, are regaled with a further paper by the Chairman of the Institute (not a chapter from a published book this time), and are permitted to enjoy a most excellent speech from Sir Edward Carson. For a revised and, we suppose, final statement of the objects that are to be pursued, we turn to the paper mentioned above, which would hardly be described as an after-dinner speech, but in the speech of Sir Edward Carson we find a timely reminder that many minds are at work along the same lines, and many movements are on foot. The six objects for which this Institute of Industry (of Great Britain and Ireland) —"Science" has now been dropped from the title—now stands will not be unfamiliar matters to readers of this and other technical and industrial journals; they are as follow:—

1. To secure the establishment of a Ministry of Industry with a properly qualified staff so that our foreign, Imperial and domestic commerce may be developed on the most modern and scientific lines.
2. To secure adequate Parliamentary representation in the House of Commons on behalf of national industry, finance, science and commerce, in order that a unified and practical policy may be adopted with regard to the development of National and Imperial industries, and that the disabilities under which manufacturers at present operate shall be removed.
3. To secure the establishment of an industrial bank or banks for the purpose of extending banking credits in so far as it affects industry in the development of home, Imperial and foreign trade.
4. To develop National and Imperial industries by the holding of annual exhibitions of the natural resources and industries of the United Kingdom, the Dominions, Colonies, and Possessions.
5. To stimulate and encourage standardisation in methods of production, organisation, and distribution. To promote and extend the application of scientific principles to industrial and general purposes. To invite the reading of papers and lectures on these subjects, and to communicate all such information to its members.
6. To stimulate and encourage the standardisation of our educational system. The demand of industry and commerce for the expert administrator and technologist must in the future become more exacting; the stability of our national industries, therefore, will depend upon the standard of knowledge prevailing in our factories and workshops. The Institute will co-operate with existing educational institutions, professional societies and trade organisations, in establishing a definite medium for the exchange of ideas between leaders of industry and education, whereby definite standards of courses of study and standards of attainment will be arrived at and mutually accepted as the guarantee of efficiency in each of the industrial professions.

Mr. J. Taylor Peddie described his Institute as being "in reality a British Economic League," and just as in the earlier days of hurry he found it necessary to reflect upon the Press of which he subsequently made use, so he now considered it politic to reflect upon other organisations created in the past for national purposes, few of which organisations, if any, had been able to give adequate expression to the needs of the hour. "They have a vague notion that something is wrong, but what it actually is they are unable to define." In the present case, however, "we have every reason to believe that we shall be able to carry them (the above six objects) into effect at an early date." But, it was added, "it entirely depends upon the support, financial and otherwise, which the British public, and particularly the manufacturers and trade organisations, are prepared to extend to us in support of our movement." Now, if these two statements mean anything they mean that the Institute of Industry has "every reason to believe" that the "manufacturers and trade organisations" will give such support to this particular movement, that we shall soon, through its instrumentality, have a Ministry of Industry, have engineering and scientific interests adequately represented in Parliament, have industrial banks established, have some big exhibitions, shall apply scientific principles to industrial purposes, incidentally hearing a few more papers on such matters, and shall standardise our educational system.

We have not space to spare to cover all the matters touched upon in the paper or address which, in our opinion, was altogether too lengthy, and too hurriedly prepared, for such an occasion, but when it is stated that the new Institute intends to co-operate with educational and

professional societies and with trade organisations, we are tempted, as an electrical and engineering journal, to ask whether any of our particular institutions or organisations have expressed their desire or willingness to "co-operate." We were informed that we could "best assist" by concentrating our energies "through one organisation entrusted with the task of developing the new National Business Policy." . . . "Assist us in that direction by not only becoming members of this organisation, but by persuading your friends also to join."

The Chairman at the luncheon, (Mr. F. J. Nettlefold), informed the two hundred gentlemen present that all of the immense burden of work from the beginning down to date in connection with the Institute had been done by Mr. Peddie, who was too modest to claim the credit for himself. We can quite understand that these and other matters with which that gentleman has been concerned during the past twelve months would be quite sufficient to tax the time and resources of any ordinary mortal, but if he lives to see the attainment of those six objects through the instrumentality of his Institute he will certainly have deserved imperishable glory.

Undoubtedly the feature of the gathering was the speech of Sir Edward Carson, who said that, judging by circulars he received from institutions and societies similar to their own, that were cropping up all around them, he came to the conclusion that many minds were now naturally busy looking with considerable anxiety to the commercial and financial future of the country and the Empire as the outcome of the war. Some of these, he said, would be mere mushroom societies, and he advised them, if they meant to be effective, to concentrate and not dissipate their forces. This anxiety he regarded as a very healthy sign. It meant that the country had made up its mind that the treasure of men and money which it was now expending should not be spent in vain, and that in framing the terms of peace, and in pursuing industrial and commercial policies after the war, we were resolved that we should purge our system of everything which was inimical to our own interests or could be used by the hostile foreigner as a weapon against us.

After a few other speeches, a resolution was carried in which those present fully endorsed and approved of the objects and policy of the Institute, and recommended "all persons or companies interested in the industrial life of the British Empire to support the Institute by becoming members."

There is a feeling that the time has come for a strong organisation of the whole engineering industries of the United Kingdom to be formed. We further have in existence our own electrical trade organisations, and these see the need for a federation of all associations of their class in order to bring combined influence to bear upon particular problems and in particular directions. Are we to understand that our firms should join the new Institute as well as, or instead of, their existing trade organisations? Or will those existing trade organisations meet the individual member's case by entering into "co-operation" with the Institute? We have no doubt that the various organisations will judge for themselves whether the Institute of Industry (of Great Britain and Ireland, Ltd.), deserving and ambitious as its objects are, is the organisation through which they will elect to "federate." Because some things may have been done in a hurry, the importance of the objects of the scheme is not affected, but the interests of engineering and electrical industries are too great for them to be subordinated to other interests.

Rubber. The rubber market has had a wildly exciting time lately, but there has been some reaction from the best figures, and there is no doubt whatever that a good deal of the buoyancy was due to the initiation of speculative operations which do not deserve to be encouraged at this juncture. If this sort of thing goes on there will probably be Government intervention, as there has been in some other essentials for the successful conduct of the war, and the speculative confraternity might do worse than take this to heart. Rampant speculation is wholly out of place in these times of strain and stress. There has been a good deal of forward buying, and premiums have been easily obtained for February-March contracts. It is very difficult to obtain material from vessels arriving owing to the shocking state of congestion which still exists at the docks, and under all the circumstances it is hard to form an opinion regarding the future course of values. The reaction witnessed in prices has certainly been a good thing for the trade. There has been too much speculation going on everywhere, but there will always be people eager to take advantage of the difficulties of their country in order to make money for themselves, and it would be an excellent thing if this could be put down with a strong hand. There seems no warranty at present for anticipating any shortage of material, and, this being the case, there is no substantial justification for the rushing up of prices. The prospect points indeed to ever-increasing quantities of rubber becoming available, and it is the more remarkable, therefore, that the tendency of forward shipments should have been stronger even than that of prompt supplies. The world's demand will probably keep pace, under normal circumstances, with progressive output, but we certainly do not want a repetition of the rubber boom. Some people suggest that the withdrawal of American inquiries has been responsible for the reaction seen in prices, but, apart altogether from this, the setback was distinctly overdue. According to the last statistical returns, the stock in Liverpool was materially reduced in December, but that in London was added to, the net result at the two ports being an increase of 357 tons to 7,434 tons, against 7,349 tons last year. The United States is now receiving regular monthly shipments from Far Eastern plantations, which the United States Rubber Co. acquired some years ago at the cost of about 7 million dollars, and it is expected that the company named will get about 10 per cent. of its supplies this year from its own plantations in Sumatra. Some manufacturers in America are disappointed that they have not booked more business from the Allies, but the explanation suggested is that England, France and Russia are far better equipped to produce the large requirements of rubber goods needed than they have been to make army shoes and leather productions, in which their productive capacity is relatively less. A recent order was placed, however, for 200,000 pairs of hip boots, but this is nothing very important. The following shows the comparative statistics of shipments from the Federated Malay States during the past three years :—

	1913.	1914.	1915.	
January	2,131	2,542	3,473	tons.
February	1,757	2,364	3,411	"
March	1,737	2,418	3,418	"
April	1,626	2,151	2,777	"
May	1,225	2,069	2,708	"
June	2,005	2,306	3,403	"
July	1,781	2,971	3,687	"
August...	2,363	1,850	3,796	"
September	2,000	2,879	3,984	"
October	2,160	2,897	4,120	"
November	2,062	2,889	4,636	"
December	2,618	3,361	5,111	"
Total	23,465	30,697	44,524	"

From these it will be seen that last month established a new record for monthly exports, eclipsing the November figures (the previous best) by no less than 475 tons, and being only 341 tons below the total exports for 1910. The total for the year is also a record, surpassing last year's total by 13,827 tons. For the sake of comparison, it is interesting to record the aggregate export of plantation rubber from the Federated Malay States for the past seven years :—

1909, 2,641 tons ; 1910, 5,452 tons ; 1911, 8,792 tons ; 1912, 15,506 tons ; 1913, 23,465 tons ; 1914, 30,697 tons ; and 1915, 44,524 tons.

THE MOVEMENT OF COAL IN HOPPERS.

An account of a research into the movement of grain, coal, &c., in the hoppers of bunkers and silos, published in the *Génie Civil*, contains particulars likely to be of interest to central station engineers who have under their charge bunkers filled with slack or other small coal. The experiments were carried out with the aid of a model representing a vertical section of a hopper, as shown in fig. 1; the front consisted of a sheet of glass, on which were ruled squares to serve as datum marks, and the side walls were of sheet steel, either straight or curved, and could be placed at various inclinations. The substance used for the experiments consisted of sand of two colours, which was

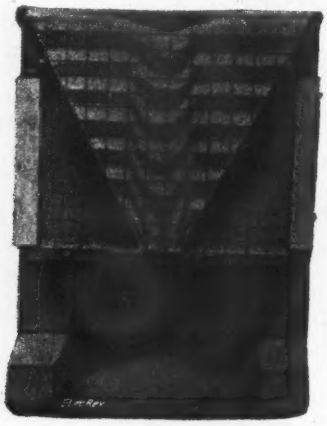


Fig. 1.—Experimental Model of Hopper.

charged into the hopper in layers, either vertical or horizontal, so as to indicate the progressive deformations of the originally parallel slices. The opening at the base of the hopper could be regulated to any desired width.

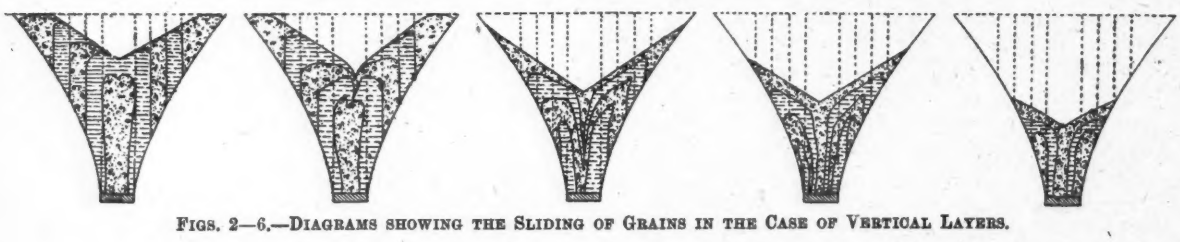
The accompanying illustrations, sketched from photographs of the experimental hopper, show clearly that it is always the uppermost layer which moves from the periphery towards the centre of the hopper, where it gradually sinks, whilst the next following layer tends to flow over it, and this holds good, no matter whether the orifice is large or small, the walls more or less inclined, straight, convex, or concave; the sand resting in the neighbourhood of the walls does not move until it becomes a surface layer, owing to the descent of all that has previously covered it. It is only when the walls are very sharply inclined that the whole of the mass of sand commences moving, and this is not a prac ical case, such a hopper being excessively high in comparison with its capacity.

Small coal, coke, &c., obeys the same laws, as one can easily prove by whitening with chalk the surface layer of the coal in a bunker, and noting the moment when the whitened pieces appear at the outlet.

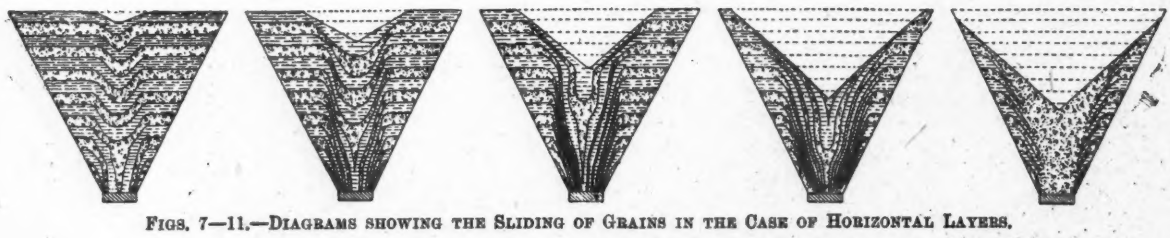
It has also been observed, when vertical iron pipes are driven deeply into the coal in a bunker, for the accommodation of thermometers to ascertain the temperature in the body of the coal, that these tubes remain *vertical* so long as the bunker is not in great part emptied, because the surface layer alone slides past them without dragging them with it, the mass of the coal remaining motionless and continuing to hold the pipes in their original vertical position, until the discharge of the coal eventually removes their support. The fact that the sloping walls of bunkers when empty show little evidence of friction further indicates that only the very last particles have slid upon them.

To summarise: The column of matter which stands upon the outlet is the first to be discharged; then the successive surface layers, and finally the parts that were at the bottom but against the walls and not immediately over the outlet.

To provide against the formation of voids in the mass, due to the jamming and arching of the larger pieces, which it is often awkward to get rid of, the best plan is to put the discharge valve at the very bottom of the hopper without any throat, and to give the outlet the full width of the base of the funnel; otherwise the pieces of coal find support in the dead angles at the bottom of the hopper and stay there, holding up those above them.



Figs. 2—6.—Diagrams showing the Sliding of Grains in the Case of Vertical Layers.



Figs. 7—11.—Diagrams showing the Sliding of Grains in the Case of Horizontal Layers.

THE PREDETERMINATION OF THE PERFORMANCE OF DYNAMO-ELECTRIC MACHINERY.

By Prof. MILES WALKER, M.I.E.E.

(*Abstract of Paper read before the* Institution of Electrical Engineers, *January 13th*, 1916.)

Almost every electrical designer has his own particular method of calculating a machine and arriving roughly at its performance. Some of these methods are exceedingly short, the figures covering not more than a sheet of note-paper; others are exceedingly elaborate, occupying some 10 or 15 sheets of foolscap.

Our ability to foretell the performance of an electrical machine, whether it be an alternating-current or continuous-current generator or motor, or a rotary converter, depends in the main upon our ability to calculate:—

1. The magnetising current;
2. The armature reaction;
3. The losses in copper and iron;
4. The temperature rise;

and, in the case of commutating machines,

5. The commutating conditions.

The last of these headings requires a paper to itself, so that this paper will only deal with the first four.

Whatever the machine may be—alternating-current or continuous-current generator, induction motor, or rotary converter—the methods of calculating these quantities are in the main the

same. It is therefore possible to have one general method of calculation for all these machines; and if such a general method could be established it would greatly simplify the work of the student of design.

The methods of design described in text-books and in articles published in the technical journals, can be broadly divided into two classes:—

1. Those which take as the basis of the design the total flux per pole: and

2. Those which take as the basis the maximum flux density in the air-gap.

In many cases where the total flux per pole is taken as the starting point, the calculation proceeds on lines somewhat similar to those employed in the calculation of transformers. For instance, in calculating the electromotive force generated in the armature, one writes

$$E_g = K_t f s \Phi \times 10^{-8} \quad . \quad . \quad . \quad (1)$$

where f is the frequency, s the number of turns, Φ the flux per pole, and K_t a coefficient depending upon the field-form and coil breadth.

On the other hand, where the flux density in the air-gap is the initial quantity kept in view, the formula for the voltage generated in a single conductor takes the form

$$e_g = v B l \times 10^{-8} \quad . \quad . \quad . \quad . \quad (2)$$

where v is the velocity in centimetres per second, B the flux density in the air-gap, and l the length of iron in centimetres.

The first method has the advantage that, after fixing K_t, it only deals with the total flux, without troubling about the distribution of the lines of force in the air-gap; but this very feature limits its application to those cases where we are content to know the mean electromotive force generated. The first formula is, therefore, not so generally applicable as the second one, which gives us a more complete visualisation of what is happening under each pole.

It is possible to have a combination of these methods, which preserves the advantages of both. Suppose we have a rotor surrounded by the stator, as in an induction motor, but that the flux in the gap, instead of changing from point to point along the periphery, is of one sign and distributed uniformly, just as it is in a homopolar machine. If B is the flux density in the air gap, r the radius of the rotor in centimetres, and R_{ps} the speed in revolutions per second, then the total flux passing into the rotor will be $B \times 2 \pi r l$, and the total flux cut per second $B \times 2 \pi r l R_{ps}$.

Writing A_g for the total working surface of the armature (the area of the gap space) $= 2 \pi r l$, we have the electromotive force e_g generated in one conductor:—

$$e_g = A_g B R_{ps} \times 10^{-8} \quad . \quad . \quad . \quad . \quad (3)$$

or

$$e_g = A_g B R_{pm} \times (1/60) \times 10^{-8} \quad . \quad . \quad (4)$$

The expression $A_g B$ gives us the magnetic loading of the frame.

If now, instead of a uniform air-gap and a constant flux density, we have salient poles and a flux density varying from point to point along the gap, the formula for the average electromotive force generated in the conductor becomes

$$e_g = K_f \times A_g B \times R_{pm} \times (1/60) \times 10^{-8} \quad . \quad . \quad (5)$$

where K_f is a coefficient depending on the ratio of the pole-arc to the pole-pitch. This coefficient, K_f, is, in fact, equal to the ratio of the area of the curve representing the field-form to the area of the rectangular field-form which we should have if the pole-arc were equal to the pole-pitch and the air-gap were perfectly uniform. Where a number of conductors, Z_a, are connected in series, as in the armature of a continuous-current generator, the formula for the total electromotive force generated becomes

$$E_g = K_f \times A_g B \times Z_a \times R_{pm} \times (1/60) \times 10^{-8} \quad . \quad (6)$$

Here $A_g B$ is the ideal magnetic loading of the frame; that is to say, the magnetic loading which we could have if the pole-arc were equal to the pole-pitch. The coefficient K_f informs us what fraction of this ideal magnetic loading we have in the machine in question.

In the case of an alternating-current generator, the formula for the electromotive force can still take the same form as (6), but we must introduce a new coefficient, K_e, to take into account not only the area and shape of the field-form, but also the width of the phase-band of armature conductors, the taking of the square root of mean square value of the voltage, and the ratio of the number of conductors in series per phase to the total number, Z_a, of the conductors on the armature. Thus, for an alternating-current generator or motor we have

$$E_g = K_e \times R_{pm} \times Z_a \times A_g B \times (1/60) \times 10^{-8} \quad . \quad (7)$$

By the use of a suitable coefficient, K_e, this formula can be used for the electromotive force generated in any dynamo-electric machine; and for general use it has the following advantages in its favour:—

1. The formula contains the term B, representing the maximum value of the flux density in the air-gap, and for many reasons it is well to have this quantity continually before us.

2. The expression $A_g B$, the maximum flux density multiplied by the total area of the active surface of the armature, has a fairly definite maximum value for a given frame or carcass; so that if we are familiar with our frame we know by a glance at our calculation to what extent we are making good use of the material. For instance, if we have an armature of an alternating-current generator having a diameter of 150 cm. and a length of 30 cm., then $A_g = \pi \times 150 \times 30 = 14{,}160$; and if we know from experience that B in the air-gap cannot be made higher than 10,000 C.G.S. lines per sq. cm., the maximum value of $A_g B$ for that frame would be $1{\cdot}4 \times 10$

As this quantity, $A_g B$, is almost independent of the number of poles, the designer soon comes to know the value it should have for any particular frame, and is able to judge at a glance how far he is utilising the magnetic circuit.

3. The maximum flux density in the teeth can be found by dividing $A_g B$ by the total section of all the teeth. This is a shorter and more convenient method than that employed where the total flux per pole is taken as the basis of calculation. In the latter case it is necessary to make an estimate of the virtual number of teeth per pole, and this is not a simple matter when the pole is bevelled.

4. The coefficient K_t has a certain recognised maximum value for a certain kind of machine. Thus, for a three-phase generator, K_t may be equal to 0·4. If it has a lower value in any calculation under consideration (as may be the case where the pole-arc is a small fraction of the pole-pitch), the designer's attention is called to that circumstance.

5. If we multiply both sides of Equation 7 by I_a, the current in the armature conductors, we get a formula for the output, containing the two expressions:—

$A_g B$, the magnetic loading; and
$I_a Z_a$, the current loading.

Both these quantities being clearly before us during our consideration of alternative designs, we can observe how one decreases and the other increases in the fight for room which occurs between iron and copper.

Any general method of design should in its nuclear form be exceedingly short, and capable of reaching rough results in the course of a few minutes. At the same time it should be capable of developments which lead to more accurate results at any stage of the calculation. Moreover, a general system of calculation should be founded upon sound principles and not merely built upon empirical rules. A method of calculation which, though rough, is based on arguments that must be right from the very nature of things, helps the designer in the habit of forming rapid mental estimates; whereas an empirical rule, however often it may be applied, never gives its user the faculty of rapidly estimating with approximate accuracy, because it does not take into account all the factors that determine the result. A busy designer would never get through his work if he stopped to calculate everything. He guesses a great deal, or makes rapid mental estimates of quantities; he has not time to calculate. He is never justified in so guessing unless he knows with fair accuracy the limits of his possible error, and knows that with that error he would still have a machine which would comply with its specification. This faculty of guessing, when properly carried out, is really a process of rapid mental calculation based upon many machines calculated and tested in the past.

In most designing offices, calculation sheets are provided. The

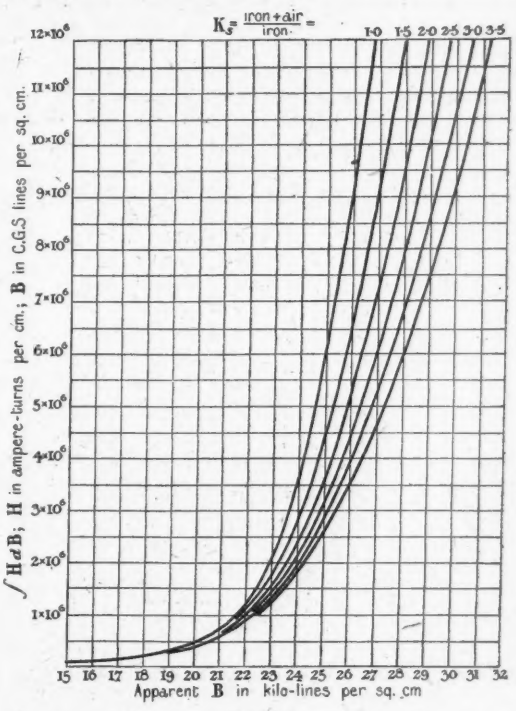


FIG. 1.

figures relating to each dimension of the machine and each important quantity are given a definite place on the sheet, so that they can be readily referred to. The process of calculating, then, merely consists in filling in the proper figures in the appropriate places, and this is done in a certain order, the slide-rule or a short calculation being used to step from one quantity to the next.

It is usual to have one kind of calculation sheet for a continuous-current generator, another for an induction motor, and another for an alternating-current generator, and so forth. If, however,

one system of calculation is employed for all machines, one printed form can be employed for all; and there is a distinct advantage in this, because an improvement in method or an increase of rating can thereby be more readily extended from one class of machine to another.

The process of plotting the field-form of a salient-pole machine in cases where it is unnecessary to take account of the saturation of the teeth is fairly simple. In cases where the teeth of the field-magnet are tapered and highly saturated, the matter is somewhat more difficult. The following remarks relate to the case of a 2,700-K.V.A. three-phase turbo-generator, having a rotor 59 cm. in diameter and 115 cm. in length, with 32 slots spaced as if there were 42, each polar projection occupying the space of five slots which are uncut.

The method proposed by W. B. Hird* for dealing with taper teeth may be employed with advantage. Curves plotted somewhat after the manner proposed by Mr. Hird are shown in fig. 1. In order to allow for the magnetic flux which leaks along the slot and the ventilating duct, it is necessary to have a number of curves, each for a particular value of K_s, where K_s is the ratio between the cross-section of the iron plus the cross-section of the air, to the cross-section of the iron, at any particular section under consideration.

The first step in the process of drawing the field-form is to plot an "air-gap and tooth-saturation" curve; indeed, where the slotting of the rotor is not uniform all round, it is necessary to have such a curve for each kind of slotting. Thus, one of these curves is required for the part of the rotor which is uniformly slotted, and another curve is required for the polar projection, which may be regarded as one large tooth. These curves are shown in fig. 2 and are marked F and G.

The first step is to find the relation between the flux density and the ampere-turns expended on the air-gap. This gives us the "air-gap line" shown dotted in the figure. For the part of the air-gap adjacent to the polar projections, where there are no slots in the rotor but only ventilating ducts, the air-gap coefficient is only 1·02.

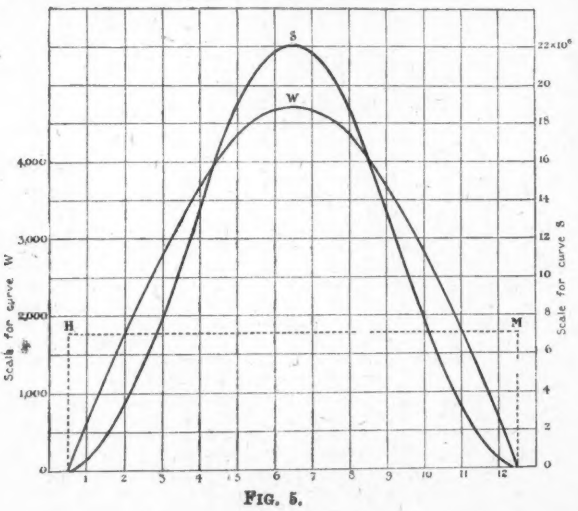


FIG. 5.

The air-gap line of this part would therefore be slightly above the thick dotted line in fig. 2.

For the purpose of finding the ampere-turns expended on the teeth, we shall consider three sections of the teeth: one, C, taken on the surface of the rotor; another, D, half-way down the teeth; and another, E, at the root of the teeth.

It is convenient to make the calculation of the ampere-turns on the teeth for three densities in the gap, say, B_g = 5,000, 6,000 and 6,500. It will be found that for B_g = 5,000 the ampere-turns on the part of the tooth lying between C and D are so small, compared with the ampere-turns on the part from D to E, that it is not worth while to apply Hird's method to the upper part of the tooth. It is sufficient to take the mean density, and find the ampere-turns per centimetre from the magnetisation curve of the iron. To find the ampere-turns on the part D E, we find the value of $\int H\,dB$ for the value of B_z at D, and the value of $\int H\,dB$ for the value of B_z at the section E; the difference, divided by the difference between the values of B_z, gives the ampere-turns per centimetre, and hence the ampere-turns for the part of the tooth from D to E; so that the total ampere-turns on the tooth are obtained. This is set off from the thick dotted air-gap line in fig. 2, and gives us a point on the "air-gap and tooth-saturation" curve. Similarly, for B_g = 6,000 and 6,500, the ampere-turns are found, and, adding these figures to the ampere-turns on the air-gap, we get the "air-gap and tooth-saturation" curve shown by curve F in fig. 2.

The saturation curve for the polar projection may be obtained in the same way, except that in this case it is necessary to take into account the leakage flux, which may be estimated by any of the known methods. The magnetisation curve for this part is shown by the curve G in fig. 2.

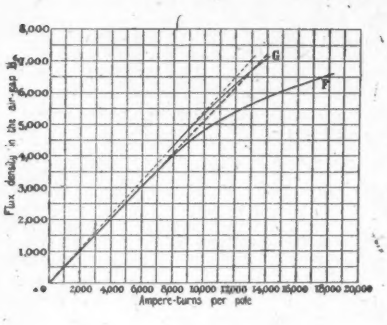


FIG. 2.

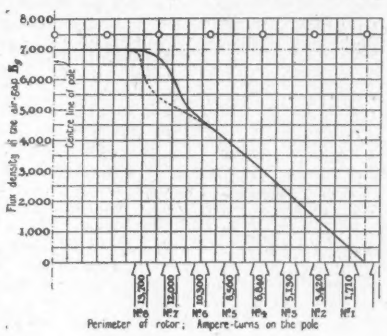


FIG. 3.

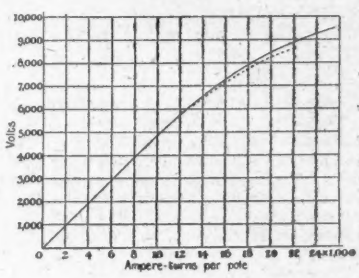


FIG. 4.

The method of obtaining the field-form at no-load, full voltage, is necessarily one of trial and error, because until we know the field-form we do not know accurately the value of K_s, and we cannot find K_s until we know the maximum ampere-turns on the poles. The usual practice is to guess the value of K_s from experience of previous machines, and from it to obtain an approximate value for the maximum flux density in the gap. From curve G we find the corresponding ampere-turns per pole. We now lay out the spacing of the slots in the rotor on the abscissa line as in fig. 3, and write down the ampere-turns per pole for the part of the iron encircled by the conductors in slot 8, slot 7, slot 6, and so on.

Referring now to Curve F, fig. 2, we are able to plot the values of the gap density opposite to each tooth. It will be seen that fig. 3 shows two curves; the inner dotted one gives the value of the flux density opposite to the tooth between slots 7 and 8, as obtained from fig. 2. This would lead to a field-form which is too narrow across the top. In order to avoid this, a steel wedge is put in the eighth slot, which avoids the super-saturation of the tooth between slots 7 and 8, and gives the field-form a broader top, as shown by the outer curve. The exact shape of this curve cannot be calculated; but the smooth curve shown in fig. 3 is sufficiently near the actual case for the purpose of finding K_s.

In order to calculate the total flux per pole it is convenient to use a coefficient which may be called the field-form coefficient, denoted by K_f, which gives the ratio between the area of the field-form and the area of the rectangle, the height of which is the maximum flux density in the gap and the base the pole-pitch. It is easily obtained in practice by running a planimeter around the curve in fig. 3, and then around the rectangle indicated by the dot and dash line. The ratio between these areas in fig. 3 is 0·625.

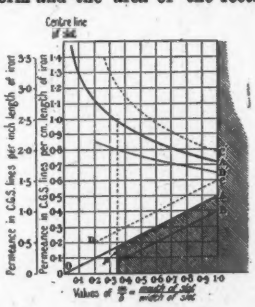

Centre line of slot
Permeance in C.G.S. lines per inch length of iron
Permeance in C.G.S. lines per inch length of slot
Values of $\frac{\text{width of slot}}{\text{width of slot}}$

FIG. 6.

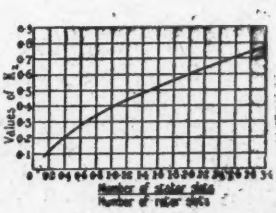


FIG. 7.

In order to plot the no-load magnetisation curve strictly one ought to go through the process of plotting the field form for a number of different excitations and find the voltage generated in each case. In practice, however, it will be found that with this type of field magnet the value of K_s does not change very much with change in the exciting current. We may for practical purposes take the voltage as proportional to the maximum flux density in the gap. If this is done we can plot the no-load magnetisation curve from the figures obtained for the ampere-turns on the central part of the pole for the voltages 6,000, 6,600, and 7,500. These are plotted in fig. 4. The dotted curve gives the increased

* "The Reluctance of the Teeth in a Slotted Armature," *Journal I.E.E.*, Vol. XXIX, p. 933, 1900.

ampere-turns required to allow for the saturation of the polar projection at full load. To find the ampere-turns at full load and 0·8 power factor one has recourse to a graphic construction.

The method of calculating the value of K_s, when the field-form and the arrangement of the armature conductors are given, can be illustrated by working out this coefficient for the 2,700-K.V.A. turbo-generator the field-form of which is given in fig 3.

In this case we have a three-phase, star-connected armature, so that the voltage between two terminals is that generated in a band of conductors occupying two-thirds of the pole-pitch. It will in general be found sufficient to calculate K_s as if there were 12 slots per pole, since a larger number of slots per pole does not sensibly affect the result. The pole-pitch is divided into 12 parts, six of which are marked off by little circles in the half field-form shown in fig 3. We begin by taking values proportional to the flux density in the gap opposite any group of eight circles, which may be taken to represent the eight conductors lying in the band; the sum of these gives a figure proportional to the instantaneous voltage. When the field-magnet has moved through the space of one conductor, the voltage generated is proportional to the sum of a new set of values, and by a successive process of addition and subtraction, we obtain figures proportional to the voltage generated in the phase-band, which are plotted as shown in curve W, fig. 5; they give the wave-form of the electromotive force generated between the terminals of the three-phase star-connected winding.

The next step is to square the values of the ordinates of curve W, and plot them to some convenient scale, as shown in curve S. Now the value of K_s is the ratio of the virtual value of the voltage actually generated in the eight conductors, with the field-form shown in fig. 3, to the value of the voltage that one would get in a homopolar machine having a flux density equal to the maximum in fig. 5, with 12 conductors in series. In order to avoid any question of the scales to which fig. 5 is plotted, one may adopt the following plan: 12 conductors would have a generated voltage proportional to 12 × 700 = 8,400. The square of this is 70·56 × 10^6. Plot this squared voltage, as shown by the dotted line in fig. 5, to a scale $\frac{1}{10}$th of that used for the curve S. A planimeter run round curve S gives a reading 1,322; a planimeter run round the dotted rectangle gives 860; this multiplied by 10 gives 8,600. Therefore the ratio of the square root of the mean square value of the voltage which is generated in the eight conductors to the square root of the mean square value which would be generated in a homopolar machine having 12 conductors is $\sqrt{(1{,}322/8{,}600)}$ = 0·392 = K_s. This method is applicable to any arrangement of conductors.

In considering the armature reaction of a polyphase armature, we have to take into account not only the back magnetomotive force which it exerts, but also the back voltage that is generated in the winding by the leakage flux which passes across the slots and around the end-windings. A great deal has been written upon the method of calculating this leakage flux.

The calculation of the amount of effective leakage across the slots is most easily carried out by means of the formula $\lambda_d = \frac{1}{3} \cdot h_e/b$, where h_e is the depth of the slot after a deduction has been made for the thickness of the insulation between the copper and the bottom of the slot, and b is the breadth of the slot. By λ_d we denote the lines across the slot per centimetre of axial length of slot for unit magnetomotive force. To this must be added the leakage across the mouth of the slot.

Whether the slot is open or semi-closed, the permeance across the mouth of the slot can be found from fig. 6. This figure is so constructed that a designer can tell at once from inspection the effect of changes in the shape of the lips upon the permeance. The shape of the lip is indicated by shading, as shown in the figure, and the shading may extend either to the line O A as shown, or to the line D C, or to the line 0·2 B. The position of the small face p may be varied, so that the fraction (mouth of slot)/(width of slot) has any value between zero and 1. At whatever point we choose to draw p, it is only necessary to continue up the vertical line from p, as shown in the figure, until it cuts one of the curves C′, A′, or B′, corresponding to the depth of the lip, and we can at once read off the permeance λ_m per centimetre of axial length of slot. For example, in fig. 6 the lip is supposed to be of the shape indicated by the shading, the value of (mouth of slot)/(width of slot) being 0·375. If we carry up the perpendicular from p to the curve A′, we find that the permeance in C.G.S. lines per cm. length of iron is 0·98. Had the lip been of a deeper design, so as to extend up to the dotted line D C, we should have carried our perpendicular up to the dotted curve C′, and the permeance would then be found to be 1·2. If the lip is of a special shape, or has the angle of one of its faces different from that shown in the figure, it is easy to sketch on our figure a lip having the same permeance and having face angles enabling fig. 6 to be instantly applied.

When calculating the leakage due to the rotor slot, it is convenient to multiply the sum of λ_d and λ_m, obtained in the way shown in the last example, by the ratio (No. of stator slots)/(No. of rotor slots). This enables the result to be added directly to the stator permeance, and the total leakage can be calculated from the number of ampere wires in the stator slot.

For roughly estimating the zig-zag leakage, a simple rule is given here, which works well enough in practice.

The reluctance of the path of the zig-zag leakage is in the main proportional to the length of the air-gap. The width of the path changes as the teeth change their relative positions. If we assume that the dimensions of the teeth and the mouths of the slots are such as one generally finds in practice, it is possible, roughly, to take into account the changing width of the leakage path by means of a coefficient, K_z, and we may write

$$\lambda_z = K_z \times \tfrac{1}{2} \text{ pitch of slot} \times 1/(\text{length of gap} \times K_s),$$

where λ_z denotes the lines of zig-zag leakage per centimetre axial length of slot, for unit magnetomotive force applied across the mouth of a stator slot. The values of K_z which may ordinarily be employed in practice are given in fig. 7 as a function of the ratio (No. of stator slots): (No. of rotor slots).

If we now add together the permeances due to the stator slot, the rotor slot, and the zig-zag path per centimetre of axial length, and multiply by twice the length of iron, we arrive at an approximate figure for the permeance of the path of magnetic leakage from one pole, so far as the first three parts of the leakage above referred to are concerned. Leaving out of account for the moment the leakage due to the end-windings, we can get the leakage in the iron paths in C.G.S. lines per pole by multiplying the total permeance calculated above by the maximum ampere-wires per slot and by 1·257.

The only really accurate way of finding the value of the end leakage of an induction motor is by experiment on the winding in question. If we have two motors built on the same frame with the same type of winding, but one machine much longer than the other, we can, by measuring the short-circuit current on each machine, calculate with some accuracy what part of the leakage reactance in each machine is due to the end-windings. When once this has been ascertained it can be put on record and the figure used in similar cases. A simple method of finding roughly the amount of end leakage that may be expected on a given machine is given in the paper. The whole matter is so complicated by accidental circumstances that it is useless to attempt any accurate calculation.

The methods of calculating the copper losses in electrical machines are fairly well standardised. So far as the iron losses in the machine are concerned, it is impossible to determine these beforehand with any degree of accuracy. Experience shows that two machines, built to exactly the same drawings, and, so far as can be ascertained, with the same care, will have widely differing iron losses, owing to small accidents in the handling of the iron stampings. It is, therefore, not worth while to make a very elaborate calculation of iron losses; many engineers use a curve giving the combined hysteresis and eddy-current losses per cubic centimetre

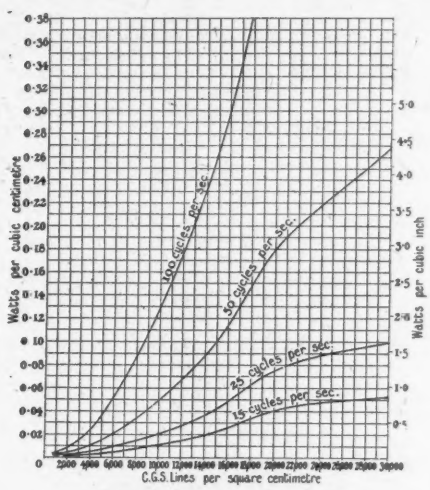

Watts per cubic centimetre
Watts per cubic inch
100 cycles per sec.
50 cycles per sec.
25 cycles per sec.
15 cycles per sec.
C.G.S. Lines per square centimetre

FIG. 8.—IRON-LOSS CURVES.

at different maximum flux densities. Such curves, to be of service, should be based on the average results obtained from running machines, rather than on purely theoretical considerations. The author has seen curves of this kind plotted on the assumption that the eddy-current losses increase in proportion to the square of the flux density, and the hysteresis losses in proportion to $B^{1.6}$. Such curves will be found in practice to give too high values for the loss in the iron at very high densities, because the hysteresis loss does not increase as $B^{1.6}$ at high densities. In fact, it has been shown that where the magnetic field is a rotating magnetic field, the hysteresis loss is zero for flux densities above 22,000; and even for an alternating field it becomes almost constant for densities greater than 22,000. In most electrical machinery the field is partly rotating and partly alternating, and we may certainly take it that the hysteresis loss does not increase at all at high flux densities such as are used in the teeth of continuous-current generators. It thus comes about that for low frequencies the curves giving combined loss take a shape somewhat like the curve shown in fig. 8, a curious inflection occurring at B = about 20,000. These curves are plotted for ordinary dynamo steel of a thickness of 0·04 cm. and subjected to as careful treatment as is consistent with ordinary shop processes. The losses shown in the curve are about twice as great as the theoretical losses calculated from the tests on samples having no burrs or short-circuits such as commonly occur in the built-up machines. Experience shows that curves of this kind will give, on the average, the losses with sufficient accuracy for commercial purposes.

Iron-loss tests taken on completed machines will generally show greater losses than are given by these curves, particularly at high flux densities. It would appear that when the teeth of a machine become saturated, the flux from the poles bulges out sideways and attacks the armature from the ends, making eddy currents in the end-plates, so that the loss sometimes increases in ratio greater

than the square of the flux density. This end-plate loss should really be allowed for separately, as its amount will depend upon factors different from those taken into account in calculating the true iron loss. A good deal of experimental work still remains to be done before we can formulate a method of calculating these end-plate losses.

Where special silicon steel is employed, the losses may be reduced by 40 per cent. when working at a flux density of 10,000 per sq. cm., at a frequency of 50 cycles, the thickness of the iron being 0·05 cm.

Predetermination of Temperature Rise.—In a previous paper before the Institution, the present author, in conjunction with Mr. H. D. Symons,* gave certain rules for the predetermination of the temperature rise in various parts of electrical machines; since that time further experiments have been made, particularly in connection with the passage of heat from the walls of ventilating ducts to the air passing along the ducts, and also in connection with the cooling of field coils.

Experiments with ducts indicate that the specific cooling constant is dependent not only upon the mean velocity of the air through the duct, but also upon the character of the motion of the air. The cooling conditions for the same amount of air passed through the duct may be three or four times as great where there are considerable eddies as where the air moves in even stream-lines. This circumstance makes experiments upon the specific cooling constant in ventilating ducts somewhat difficult and inconclusive, and is the cause of the wide divergencies in the results obtained by different experimenters.

In order to arrive at more definite values, the author and Mr. W. H. Blythe made a number of experiments with various kinds of ducts over a considerable range of air velocity and under varying conditions. The results of these experiments are contained in a contribution presented to the Institution.

These results can be shortly stated as follows:—If we denote the flow of heat from the walls of the ventilating duct, expressed in watts per square centimetre per degree C. difference of temperature between wall and air, by the symbol h_v, then we find that over a wide range of speed $h_v = K_v v$, where v is the mean velocity of the air in the duct measured in metres per second, and K_v is a constant depending on the character of the duct. K_v is very much affected by the amount of baffling of the air in the duct. A circular duct 2 in. in diameter gave a value of K_v as low as 0·00033 when the air passed through with long steady stream lines, but the addition of baffles brought the value up to 0·0011. For ordinary flat ducts about ½ in. wide it would seem that the constant K_v may be anything from 0·0005 to 0·0014, depending on the amount of eddy currents in the air in passing along the duct. Where the ducts are dirty, the value of K_v may be very much lower still.

The cooling of the iron of the stator is considerably helped by the conduction of the heat into the cast-iron frame, from which it is passed by radiation and convection to the surrounding air. It is generally impossible to make an accurate calculation of the amount of this conduction. The author has found that with ordinary box-type cast-iron frames, with the punchings dovetailed into the cast-iron, to allow 0·15 watt per square centimetre is suitable where a temperature rise of 40° C. is permissible.

NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

A Photoelectric Relay.

The sensitive photoelectric relay illustrated herewith, which may be used for various scientific and technical purposes, consists of a glass tube 6 cm. in diameter and 19 cm. in length, in which the aluminium plate D′ can be moved toward the wire net B by means of a magnet acting on the iron cylinder E. A little rubidium is distilled in the vacuum through the side tube F on the plate D′, which in this way can be uniformly covered with the alkali metal. Hydrogen will then be admitted and the surface of the alkali metal rendered sensitive by means of the glow discharge. The hydrogen will be replaced by argon until the sensitiveness is a maximum. The light of an incandescent lamp at a distance of 50 cm. passes through the two wire nets B and C and liberates the electrons in the position D from the rubidium-hydrogen. These electrons move under the influence of a small potential difference from D to B, where they enter the electric field between C and B, which is so strong that ionisation by collision takes place. Through this process the current between B and C becomes very large. The currents between D B and B C can be varied within wide limits by a variation of the pressure and of the distances between the electrodes.

In the course of experiments conducted in the physics laboratory of the University of Illinois, Urbana, the distance between B and C was kept constant, about 5 mm., while the distance between D and B was varied from 3 mm. to 30 mm. The primary or photo-electric current between D and B varied from 3×10^{-10} to 10^{-7} amp., and the secondary or ionisation current from 10^{-7} to 10^{-5} amp. The maximum secondary current was sufficient to close an ordinary relay. The secondary voltage required for the maximum current was 136 volts. A further increase of this tension produces a glow discharge which persists even when the primary current is interrupted. This apparatus thus acts as a relay, a weak primary current closing the circuit of a relatively strong secondary current.

* *Journal I.E.E.*, Vol. 48, p. 647, 1912.

Amongst other applications the device may be used for the detection of electromagnetic waves; a telephone relay for weak electric currents; a thermostat for the regulation of temperature

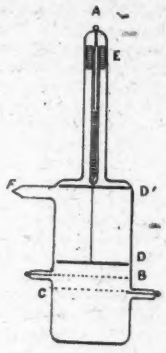


FIG. 1.—SENSITIVE PHOTOELECTRIC RELAY.

within a very small fraction of a degree; and a light sensitive relay. In lecture experiments performed by means of this relay a beam of light has been made to ring a bell or to turn on a group of incandescent lamps.—Jacob Kunz, in the *Electrical World*.

New Ultra-violet Lamp.

It is reported that a Mr. Simpson, who was experimenting with rare metals, recently discovered that the light emanating from an arc between certain ores possessed powerful therapeutic qualities, greater than those of the Finsen lamp, as it is richer in ultra-violet rays. Investigations are in progress at St. Bartholomew's Hospital, London, and the results obtained so far have been very promising.

LEGAL.

Re CEDES ELECTRIC TRACTION, LTD.

A DEBENTURE-HOLDERS' action by the Austrian Daimler Motor Co., Ltd., against the Cedes Electric Traction, Ltd., was mentioned to Mr. Justice Neville in the Chancery Division on Friday last, upon a motion by the plaintiffs for the appointment of a receiver and manager.

MR. DIGHTON POLLOCK, for the plaintiffs, said that the ground of the motion was jeopardy. A petition to wind up the Cedes Co. was down for hearing on Tuesday, and it would be necessary to find money to pay this week's wages.

MR. WARD COLDRIDGE, K.C., for the defendant company, said there was sufficient money at the bank to pay the full amount of the company's indebtedness and the wages, but the petition had created a difficulty in getting at this money. The company had important and remunerative contracts running.

HIS LORDSHIP appointed a receiver and manager with liberty to borrow enough to pay the week's wages if necessary; but he recommended the parties to lay their heads together and come to some agreement, so that the petition could be got rid of before Tuesday.

ALLEGED FRAUDULENT TRAMWAY CLAIM.

MR JUSTICE SCRUTTON in the King's Bench Division, on January 13th, entered judgment for the London County Council in a claim for damages by Henry Barker, of Tottenham, for injuries alleged to have been received in a tramway mishap. The jury held that the claim was a fraudulent one from beginning to end.

It was stated that a collision occurred between the car in which Barker was a passenger and another car at Ponder's End, on June 11th, 1914. The plaintiff alleged that a fellow passenger weighing 19 stone was thrown on to him, causing concussion of the spine and other injuries.

On the application of counsel for the defendants, Mr. Justice Scrutton ordered the papers in the case to be impounded for further consideration.

WYNSTANLEY, *v.* MACARTNEY, MCELROY & CO., LTD.

MR. JUSTICE SCRUTTON, in the King's Bench Division, on January 12th, gave judgment in this action, which was heard last term. He gave plaintiff £100 damages for the wrongful dismissal from the directorship. He gave judgment for the defendants for £800, £90 and £48 which the plaintiff had obtained from the company, while the defendants failed in their counterclaim for £35 and £192 and 200 Malta Tramway shares. As each side had partly succeeded, he would save them expense by holding that each should pay their own costs. Concluding, his Lordship expressed his great regret that a part of the burden of this litigation would fall on infant shareholders whose interests had been entrusted to unfaithful and incompetent people. He hoped means would be found to remove some of that burden to the directors, and especially to Mr. Frank Macartney, who, since his father's death, had much to answer for. He was quite unfit to hold the position of director of the defendant or any other company.

MUNITIONS COURT CASES.

AT the Rochdale Munitions Court on the 6th inst., a labourer at the Rochdale electricity works asked for a leaving certificate, which he alleged had been withheld. He stated that he had been discharged on December 22nd, and had been unable to get employment elsewhere because he had not the certificate. The borough electrical engineer, Mr. C. C. Atchison, said the request for a certificate had not reached him, or he would have granted one. He agreed to give applicant a leaving certificate and a monetary grant for the mistake.

At the same Court another employé at the Rochdale electricity works—a turner—desired a leaving certificate in order that he might do work of a more particular character in the manufacture of munitions. He said he worked on a lathe only five hours a day, and, being a rheumatic subject, the steam and heat affected his health. Mr. Atchison said the works supplied electricity to important works. He was willing to release the applicant as soon as he could be replaced. The application was eventually withdrawn on the understanding that the certificate should be given within a month.

Before the Oldham Munitions Tribunal last week, Messrs. Ferranti, Ltd., lodged a complaint against five youths who "did not work diligently under the rules." It appeared that at 6 o'clock one morning the five youths were found by the night watchman playing cards by the light of a candle. They had been on the night shift, and should have gone away at 7 a.m. Three of the lads said they were not playing for money, another said he had merely stopped to watch the play, and the fifth said they were playing banker for money. The youth who said he had merely stayed to watch was let off, and the remainder were fined 5s. each.

Another case at the same Court concerned George W. Sugden, a crane-driver employed by Messrs. J. P. Hall & Co., electrical engineers. Sugden asked for a leaving certificate, his case being that when he started as a spare man, on November 9th, he understood that his commencing wages of 23s. were to be increased to 27s. if he agreed to take the job on permanently. He now found he would have to wait six months for a rise, and as he had an offer of 35s. a week, he wanted to leave to better himself. He complained also that his present work was injurious to his health and eyesight. Mr. Hall (for the firm) said that the man had been engaged entirely on important work. He was not a spare man at all, and his wages were started at 23s., and would advance to 27s. which was the standard. It was also alleged against Sugden that he had done things with a view to getting discharged, one instance cited being that he ran a load over some men who were working, which was contrary to the rules. Mr. W. Sellers (chairman) asked how a man could be indispensable who was only worth 23s. per week. Mr. Hall: He is one of the links in the chain forming an indispensable whole. There is no man indispensable if you put it that way. Mr. Hall added that they would have difficulty in replacing this man, and it would take a week or a fortnight to teach a man. Sugden's application was granted.

The question whether the electricians in a Govan shipyard should receive an allowance for the half-hour tea interval when ordered to work overtime was raised last week at a Local Munitions Tribunal in Glasgow. The case was raised at the instance of Messrs. Alexander Stephen & Sons, shipbuilders, Linthouse, who charged a number of their workmen with having, on December 22nd, infringed the rules of the Munitions Act by refusing to work after 7.30 p.m. unless they were paid for their tea interval, contrary to the practice of the establishment.

Mr. Biggart appeared for the firm, while Mr. A. Stewart, Electrical Trades Union, represented the men.

According to a Scottish paper, it was stated in the course of the evidence for the prosecution that the men, who were electricians, had declined to work overtime unless they were paid for the half-hour tea interval. After being informed that the matter would be referred to the Munitions Tribunal they still refused.—In answer to the men's agent, the foreman electrician, who had given the order to work overtime, said the men refused to work overtime unless they received payment for the tea interval. In the presence of witnesses the electricians were asked individually to work overtime, and witness had found out that the majority of them were perfectly willing to work, but said "they were on the horns of a dilemma," as they had been instructed by the Union not to work without payment for the tea interval.—MR. STEWART remarked that this matter was irrelevant to the case, but the CHAIRMAN held that it was an answer to a question.—For the defence, a workman said he was employed with a firm who did sub-contracting work for Messrs. Stephen, and he received payment for the tea interval.—MR. STEWART said this was a case for arbitration, and the workmen were prepared to go to arbitration on the question. They had endeavoured to have a conference on the subject with the employers, but had been refused. He thought the men should be dismissed, pending arbitration.

The Court found that the charge against the men had been proved, and fined each of them 10s., payable in two weekly instalments to be deducted from their wages.

TAYLOR & FARLEY *v.* THE WEST BROMWICH CORPORATION

THIS case was again before Mr. Justice Neville in the Chancery Division on Friday.

MR WILLIAM MACKENZIE, for the plaintiffs, said that in this case his Lordship had granted an interim injunction over the day, restraining the Corporation from discontinuing or curtailing the supply of electrical energy for power to the plaintiffs. By an agreement made in 1912, the plaintiffs were entitled to a supply of electrical energy for five years, but recently the Corporation had sent a letter threatening to cut off the supply of energy during certain hours.

MR. WHEELER, for the defendant Corporation, said there was a difficult question of law to be decided on the contract, and this could best be dealt with at the trial. Until then the Corporation would give an undertaking in the terms of the order made over that day.

His LORDSHIP: I remember the case, and I think your clients are acting rightly.

MR. WHEELER: I will not discontinue or curtail the supply at any time during the night or day; but plaintiffs should give an undertaking that if defendants succeed at the trial they will pay for power supplied to them at the same rate as other consumers.

His LORDSHIP: I don't like that form of undertaking. Let it be in the usual form.

CECIL HODGES & CO., LTD., *v.* ELLIS & WARD.

IN the City of London Court, on January 17th, before Sir John Paget, Bart., K.C., Deputy Judge, an action which had been remitted from the High Court of Justice, was brought by plaintiffs against defendants, to recover £96 for an electric lighting installation at Bristol. Mr. Clements appeared for the plaintiffs, and Mr. Lincoln Reed for the defendants. Mr. Clements said in respect of the claim £69 had been paid into Court in respect of switchboards and electrical appliances, and there was no dispute about the delivery of the goods, but the defendants said they were entitled to set off £27, and counter-claim for £24, because certain goods were not supplied that ought to have been supplied, or work which ought to have been done had not been done. They further said they had to employ men and had to make temporary arrangements for power fuses and lighting fuses, and go to other expense in travelling from Bristol to London. Mr. Reed said a large number of ivorine labels ordered had not yet been delivered. Mr. Clements said the whole contract was based upon a quotation of December 11th, 1914. Full details of the contract were given, and in the course of the hearing Mr. Cecil Hodges, the managing director of the plaintiff company, was called. He said that they still had some labels to be sent. They did not get the instructions for them until a long time after they had the instructions for the boards. Great delay was caused by the Government war work, which was being done by the foundry people. They had not to do the drillings in the switchboards. He had never heard a word about the defendants having, as now alleged, to get temporary plant and make journeys to London, until the present proceedings. It was an oversight on his part not to tell the defendants that he could not execute the order within four weeks when the alterations were made. No doubt the defendants wanted quick delivery, and they did the best they could in the circumstances. The reason why 97 labels were not supplied was because they had been overlooked. Mr. Reed urged that after that admission plaintiffs could not recover at all because the contract was indivisible and plaintiffs had not fulfilled it. The Deputy Judge ruled against that contention. Mr. David Dalrymple, foundry manager, Wolverhampton, said he made the iron cases for the plaintiffs. The work was very much delayed because of important work. Mr. Ellis said it was very important that the labels should be put on the fuses, as everything was done by motor in the factory in question. It was all electrical work. At present they were incomplete. For the defence evidence was called to show that the plaintiffs had not carried out their work according to specification. The result was that the defendants had got the work done elsewhere at an expense which was now counter-claimed for. The Deputy Judge said he quite realised the importance of labels being put on the switches, and that the haphazard method adopted by the defendants with high-power machinery was very unsatisfactory. He held that the plaintiffs were entitled to recover £69 paid into Court, but no more. He gave them judgment for that amount on the claim, without costs, and he awarded the defendants £24, with costs on the counter-claim, that being the amount of expenses they had been put to in consequence of the plaintiffs not carrying out their contract.

CONSOLIDATED DIESEL ENGINE MANUFACTURERS, LTD.

THE summons in the liquidation of this company which asked for the appointment of an additional liquidator with Sir William Peat again came before Mr. Justice Astbury in the Companies Winding-up Court; the former hearing was in November.

MR. H. COZENS-HARDY, K.C., said the application was on behalf of three members of the committee of inspection of five, who were of opinion that the liquidation should not be solely in the hands of Sir William Peat. They made no reflection on the personal integrity of that gentleman, but they thought it was undesirable that he should remain in sole control. On the suggestion of his Lordship, a meeting of shareholders was held on December 1st for the purpose of expressing their wishes in the matter. On a large poll 207,333 votes were recorded in favour of the sole control by Sir William Peat, 30,000 in favour of an additional liquidator, and 135,000 in favour of his removal. That amounted to a majority of five to four in favour of Sir William Peat's continuance alone. If one firm's holding was deducted from the figures, the result would be seven for and eight against his continuance alone. It was said that there was a large claim against this firm, and that their votes ought to be deducted.

His LORDSHIP said he had received a message from the Official Receiver that Sir William Peat would have no objection to the appointment of a joint liquidator if his Lordship approved of that course.

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Mr. Martelli, K.C. (for Sir William Peat), said the views of the majority should be given effect to. They did not desire a change, and Sir William Peat did not object to an additional liquidator "if the shareholders desired it."

His Lordship, in giving his decision, expressed his surprise that Sir William Peat did not come to the conclusion in his own interests that there should be a co-liquidator. He, however, saw no kind of case for removing him, and he had no jurisdiction to adversely appoint a co-liquidator unless he re-summoned the original meetings in the winding-up. That he did not intend to do. He had no alternative, though he regretted it, but to act upon the decision of the small majority of shareholders and to refuse the application. As, however, it was a perfectly proper summons to bring, his Lordship ordered the costs of all parties to be costs in the liquidation.

In *re* Barton-Wright.

Before Mr. Justice Scrutton, in the King's Bench Division last week, application was made on behalf of a judgment creditor, Mrs. Beattie, for E. W. Barton-Wright, electro-therapeutic specialist, Oxford Street, to show cause why he should not liquidate a judgment debt of £224 by instalments. The evidence, as reported in the *Times*, showed that defendant was advertising in certain journals that the rush of patients had necessitated an increase in the number of his dressing rooms. The Court ordered debtor to pay £12 a month, but debtor said it was quite impossible—a remark which drew from the judge the remark, "Then you will probably go to prison if you do not pay!"

Tinol Soldering Paste.

On Monday an application was made in the Patents Court, set up to deal with the patents of alien enemies, before the Controller, Mr. Temple Franks, and the Deputy Controller, Sir Cornelius Dalton, by Messrs. Bi-Metals, Ltd., of 57, Lant Street, Southwark, who asked for rights to use the trade-marks of Tinol in connection with two German patents—Nos. 13,557 of 1903, and 17,624 of 1904—under which they had been given licence to manufacture by the Board of Trade.

Mr. Inskip, K.C., appeared for the applicants, and stated that the patent No. 13,557 was registered by Jacob Callman, of 65, Gitschinerstrasse, Berlin, and Rudolf Bormann, 26, Walterstrasse, Berlin-Rixdorf, and claimed a method for intimately associating finely powdered soft solder, such as tin or tin alloy, in a paste, with a deoxidising agent like zinc chloride, or ammonium chloride, or both, and a thickening body such as cellulose, which burns easily and leaves no trace.

The other patent, registered by Maximilian Leisel, of 10, Handelstrasse, Köln-am-Rhine, and Rudolf Küpper, 7, Grandorferstrasse, Bonn-Endenich, provided a substitute in electrical work for soldering with resin and tin. In addition to the aqueous solution of ammonium chloride, or chloride of zinc, or the double chloride for soft solder, it used borax, water-glass, or glass powder, for hard soldering, and met the three requirements of (1) a soldering metal in a fine state of division, (2) a flux which did not leave behind an oxide residue to impair the joint, and (3) a neutral liquid organic substance which did not evaporate until the soldering metal or the flux had done its work. The soldering flux-chloride, or borax, was mixed with glycerine, and the metallic powder or finely comminuted metal. The neutral liquid organic substance protected the metal from oxidisation.

Mr. Inskip explained to the Court that in October, 1914, the applicants were the English agents for a German manufacturing corporation. The Board of Trade had granted Bi-Metals, Ltd., the right themselves to manufacture under these patents, on payment of a royalty of 10 per cent. on the gross selling price. From the Patents Court had come the suggestion that they should take the trade marks as well, and they were now applying for them. As selling agents in this country before the war for the Küppers Metallwerke Gesellschaft m.b.H., of Bonn-am-Rhein, the applicants had the option to purchase the patent rights. That option had expired before the war, and they had then entered into negotiations to renew it. They, of course, had no relations with the German firm now.

Mr. Percy Good, a director of the applicant firm, was asked whether they had ever had any complaint of the efficiency of this method compared with the old mode of soldering.

The Witness answered that they had had one complaint since the war broke out. That was when for the purposes of munitions, all the pure glycerine was required. Bi-Metals, Ltd., attempted to manufacture with crude glycerine, and found that it did not answer. Apart from the 2 cwt. or so made then, they had never had any difficulty. They at once communicated with the authorities and got leave to obtain all the pure glycerine they required. They continued to receive repeat orders from engineering and other firms which used the composition in all directions.

The Controller of Patents observed that very few trade-mark rights had been granted by that Court, because he considered it desirable that the marks should apply strictly to the articles with which they had been associated. Here, however, was a case apparently in which this condition was fulfilled, and as Bi-Metals, Ltd., were manufacturing in this country they wished to place the label on the tins of paste, as had been done before the war. The contents were identical. They would hear shortly from the Board of Trade as to their application.

ELECTRICAL PRECIPITATION OF SMOKE AND DUST.*

In an address recently delivered in New York, and reported in *Metallurgical and Chemical Engineering*, Mr. Linn Bradley stated that in the application of electricity to the recovery of valuable by-products a Californian, Dr. F. G. Cottrell, had done more to advance both the science and the art than any other individual.

The problems of removing from gases minute particles suspended therein were of great variety, and existed not only in thickly settled industrial communities but also in sparsely settled States. Requests for a solution of specific problems had been received from north-eastern Canada, Cuba, Mexico, Hawaiian Islands and Alaska, to say nothing of inquiries from across the seas. In New York City inquiries had ranged from the collection of diamond chips suspended in a small volume of air up to the collection of cinders and small pieces of coke from gases arising from boilers under which about 3,000 tons of coal were burned every 24 hours. It was obvious that the saving of values was the object to be attained by collecting the diamond chips, while in the latter case the cinders and coke particles constituted a serious nuisance in the neighbourhood.

Portland cement plants generally had severe dust problems, as they fed finely-ground materials into long cylindrical kilns near the point where large volumes of gas were rapidly emerging, and in such a manner that the gases picked up a large quantity of dust. Instances were known where the quantity of dust from a cement plant approached from 200 to 400 tons per day, which was scattered broadcast over the district surrounding the plant. At iron blast furnaces the finely-divided ore was charged in such a way that dusting was facilitated. Reports had been obtained which showed that the total amount of iron ore and coke lost in this manner amounted to a very large tonnage yearly, and this dust might be worth from $3 to $3.50 per ton. Calculation had shown that by removing the particles from the gases from one iron blast furnace, without cooling the gases, the value of the conserved heat energy might amount to about $25,000 per annum.

It was not unusual for a fair-sized smelter to waste 1,000 tons of sulphur daily by discharging it into the atmosphere in the form of sulphur dioxide, notwithstanding the fact that sulphur was a very necessary commodity.

Waste gases at smelteries and refineries also contained metals and other elements, the recovery of which often would be warranted for the additional revenue which they would produce; investigations at one smeltery showed that metals having a gross value of approximately $4,000 per day were being discharged into the atmosphere.

In large brass foundries perhaps 3 per cent. of all the zinc charged into the crucibles was burned off or volatilised and discharged into the atmosphere, thus constituting an economic loss aggregating many thousands of dollars per annum. In the production of metallic zinc from ore a considerable percentage of zinc was lost as fume.

At a sulphuric acid plant where a large quantity of acid was concentrated in stills, investigation showed that 2 to 3 tons of sulphuric acid were being wasted daily as mist. At another plant hydrochloric acid fumes had been killing vegetation in an adjacent park, but at present the trees and shrubs were thriving, as the acid fumes were being collected electrically.

In ventilating modern public buildings, and even up-to-date factory buildings, it was considered desirable to control the temperature and humidity of the air and remove all dust, bacteria, etc. In one recent installation it had been found that by circulating 50,000 cu. ft. of air per minute in a closed system, removing dust, etc., by electrical precipitation, the saving in steam which would be required for preheating this quantity of air in cold weather much more than paid a good return on the investment. Here the primary object was conservation of steam.

With a proper arrangement of pipes or plates and wires acting respectively as "collecting electrodes" and "discharge electrodes," it was possible to produce a discharge of electricity from the wires to the pipes or plates through gases present between them.

In electrical precipitations it was customary to employ very high voltages, such as, say, 75,000 to 100,000. With such voltages as these it was possible to subject a gas to such strains that it was changed from a non-conducting to a conducting medium.

Each of the particles of dust or fume collected a charge of electricity of the same polarity as the discharge electrode, and since two bodies charged with the same kind of electricity repelled each other, the particles were driven away from the wire and drawn toward the pipe or plate (collecting electrode). The more electricity upon a particle the greater was the force acting upon it, therefore in practice a strong discharge was maintained. Furthermore, the greater the voltage between the electrodes the stronger was the precipitating force; this made it desirable to operate at a voltage just below that where a spark or arc would form. Moving gases exerted a force upon suspended particles, and the greater the velocity the

*An article on this subject appeared in the Electrical Review of May 14th, 1915.

greater was this force; hence, with a given precipitating apparatus, there was an upper limit to the gas velocity at which the suspended particles might be completely removed.

Direct current at high voltages was required, as alternating current at commercial frequencies was not suitable for this work. Large volumes of gases required, as a rule, more power than smaller volumes, but the power consumption was affected by other factors. Static machines did not furnish enough power for commercial installations and were not dependable. In commercial installations ordinary black iron pipes about 12 in. or 18 in. in diameter by 15 ft. to 20 ft. long were in general use, connected to a gas chamber at each end in a manner similar to that in a tubular boiler. With this arrangement gases and suspended particles might readily be distributed to the various pipes, and through them to another gas chamber, having been cleaned during such passage. The cleaned gases might be conducted to other places as desired.

The precipitating apparatus might be designed for either hot or cold gases, and for corrosive or non-corrosive materials, and the product might be collected either wet or dry as conditions might indicate. In treating gases containing particles of acid held in suspension, materials such as lead or stoneware were employed to avoid serious corrosion. Heat-insulating materials might be employed in the apparatus to lessen the loss of heat energy when desired. The gases might be either forced or pulled through by fans or other mechanical means, or if the gases were sufficiently warm natural draught might be employed. When treating gases which were explosive when mixed with air, they were kept under a pressure slightly greater than atmospheric until they had been cleaned.

The high-voltage direct current was obtained by transforming low-voltage into high-voltage alternating current and then converting or rectifying the latter into an intermittent, high-voltage direct current. The amount of power required in commercial installations was relatively low, generally being much smaller than that necessary for any other gas-cleaning system.

A unique advantage of electrical precipitation was its ability to collect even the most minute particles. Another interesting feature was that components of gases of different volatilities might be separated by what had been termed "fractional precipitation." In this method the gases were treated while at a high temperature to remove those materials which were then either solid or liquid, and then after further cooling the gases were subjected to another treatment in a separate precipitator. Arsenic trioxide of high purity had thus been separated from copper, iron, zinc and other materials. It would be possible to obtain water-free tar in gas plants by this means, and also it might be possible to collect tars of different compositions.

Many other instances could be given, and the author hoped that chemists, engineers and others would give more earnest consideration to smoke, fume and dust problems and endeavour to solve them, not only for the sake of better atmospheric conditions and for aesthetic reasons, but also for the values which were to be obtained when their solution was accomplished.

WAR ITEMS.

Trade after the War.—At a meeting of the Advisory Committee to the Board of Trade on Commercial Intelligence held last week, among matters considered were proposals for the safeguarding and promotion of British trade after the war; the more systematic collection and exhibition of samples of German and Austrian goods competing with British manufacturers in Colonial and foreign markets; and questions relating to the work of the Commercial Intelligence Branch of the Board of Trade. Further reference to the work of this committee appears on page 76.

Lord Derby will be present at the meeting which is being organised for January 31st at the Guildhall.

The London Chamber of Commerce had before it last week the report of a special committee on the subject of "Trade during and after the war." The main recommendations, according to the "Financial Times," are the following:—

1. That any measures which may be considered in connection with trade during and after the war should provide: (a) For preferential reciprocal trading relations between all parts of the British Empire; (b) for reciprocal trading relations between the British Empire and the Allied countries; (c) for the favourable treatment of neutral countries; and (d) for regulating, by tariffs and otherwise, trade relations with all enemy countries, so as to render impossible a return to pre-war conditions and for stimulating the development of home manufactures and the consequent increased employment of native labour.

2. That steps should be taken to prevent the dumping and under-valuation of enemy goods into British markets after the war.

3. That discriminatory taxes be levied on the tonnage of all enemy ships using the ports of the British Empire.

4. That the Government be urged to encourage the production and utilisation of raw materials and manufactured goods within the Empire under such legislative conditions as will prevent their being controlled by or on behalf of subjects of enemy countries.

5. That the naturalisation laws of the Empire be amended so as to prevent the abuses which have been disclosed since the commencement of the war.

6. That further legislation, especially in regard to enemy holdings in British companies or firms, is necessary to safeguard British subjects from the consequences of the policy of the German Government in organising its subjects residing in any part of the British Empire for commercial, industrial, financial and economic purposes in time of peace with a view to military aggression in time of war.

7. That His Majesty's Government be urged to guarantee for a period of years the continuance, by subsidy or otherwise, of new, or "key," industries established prior to and since the commencement of the war.

8. That with a view to promoting the development of British trade under altered conditions caused by the war, His Majesty's Government should appoint a Minister of Commerce of Cabinet rank, to whom certain of the functions of the Board of Trade and other departments should be relegated.

At the House of Commons last week Sir John Randles, M.P., presided over a meeting of the Commercial Committee. He said that he had accepted the invitation to attend the Congress of the International Commercial Committees of the Parliaments of Europe and Japan at the Sénat in Paris on the 6th, 7th and 8th March, to discuss the economical and commercial questions arising out of the war.

Platinum Prices.—According to an Ekaterinburg dispatch it is never easy to establish what the price of platinum is. No matter what the quotation may be in the Press, it is always understood by buyers that such price is rather nominal and is subject to negotiation. It was stated in a Petrograd paper a few weeks ago that, in view of the proposed platinum monopoly in Russia, the important platinum producers have begun to force up the prices considerably, in order that the platinum which they controlled, amounting to about 300 poods, might be disposed of to the Government on a basis satisfactory to them. The price of platinum, which not long ago was eight roubles per zolotnik, had rapidly risen to 11 to 12, and even more, roubles. Business generally in the Urals in platinum is doing somewhat better than immediately before the war. At Nizhni-Tura, buyers are offering 10 roubles for the crude platinum, and will buy any quantity. Before the war the highest price was nine roubles 80 copecks. At the mines there is some scarcity of labour owing to the high prices that it obtains elsewhere.

Goods of Enemy Origin.—The Board of Trade has issued a warning to importers stating that they are under an obligation to take all necessary steps to satisfy themselves that goods they propose to import are not of enemy origin. Failing evidence that they have done so, the goods, should they prove, as a result of examination on arrival, to be of enemy origin, will be liable to seizure even though accompanied by Consular certificates of origin. Importers who are offered goods (especially goods hitherto mainly derived from enemy countries) by firms abroad respecting which they have insufficient information are strongly advised to defer payment until the goods are delivered, and to make it a condition of payment that the goods are not only accompanied by certificates of origin in proper form, but are passed on arrival by the Customs authorities of the United Kingdom.

Australia and Future Trade.—Reuter reports that on January 13th, at Melbourne, the Associated Chambers of Manufacturers presented to Mr. Hughes (Federal Prime Minister) a series of resolutions framed with the object of preventing Germans from regaining their trade after the war. Mr. Hughes, in replying, said it would be incredible folly if victory secured on the field should leave Germany in possession of economic opportunities. The war must be carried on in the field of industry with a determination equal to that shown by the Allies on the field of battle. The Premier added that he was not in favour of trade with Germany "during the war, after the war, or at any other time."

Trade with Hong-Kong.—The Board of Trade is notified by the Colonial Office that, according to telegraphic information from the Governor of Hong-Kong, complaints are being received there that some merchants in the United Kingdom are declining to complete or undertake orders from Hong-Kong merchants on the ground that such merchants are not on the white list of persons and bodies of persons to whom articles to be exported to China may be consigned under the terms of the Proclamation of September 24th, 1915. It should be noted, however, that the Proclamation referred to does not apply to Hong-Kong; Hong-Kong is not affected by the white list regulations.

Petroleum Economies in Russia.—On the basis of the information submitted by the 1886 Company on the quantity of current supplied to the town mains from the Bogorod station, the Moscow Town Council has determined that on the average the company may use the current of the "Elektroperedachi" concern to the extent of one-fifth of the total consumption of the town, which would mean an economy for the town station of 88,000 poods of petroleum. The cost price of the current for the town station from the 1886 Company is fixed at 3.3 copecks per kw., and from the "Elektroperedachi" at 2.9 c. The difference in favour of the company per month works out at an average of 10,000 roubles.

"Key" Industries.—The "Times" states that it is understood that the Advisory Committee of the Board of Trade have practically finished a report on "Key" industries—trades without which industries of national importance cannot be maintained. Our contemporary remarks:—"The publication of this interesting and important document may be expected shortly. Its contents may be unpalatable to many, but there can be no question that the public ought to know exactly what these business men have told the Board of Trade. Rugged facts are of more importance than polished sentences in our present position."

In a fuller statement on the matter appearing in the "Times" of Wednesday, it is understood that the Advisory Committee in their report advocate Government subsidies for certain industries, while protection by tariff is also approved by overwhelming majorities. Electrical apparatus and porcelain are among the trades concerned. A section of the report is stated to be devoted to the great need for scientific training and research.

Women in Power Stations.—Owing to increased business and to decreased staff, both due to the war, the Glasgow Electricity Department is experimentally employing women in power and sub-station work for record-taking and switchgear manipulation.

Enemy Capital Holdings.—The "Financial News" prints a copy of a circular which has been issued to the secretaries of all companies by the Registrar of Joint Stock Companies asking for information of an important nature. A form is enclosed whereon the recipient has to fill in, within a week, the name of the company and the nature of the business, together with the amount of capital in the company held by persons resident in foreign countries, separating, according to various countries, the capital so held.

Australia and German Shareholders.—Reuter's Melbourne correspondent reports Mr. Hughes, the Prime Minister, as saying at a banquet organised by the Metal Exchange, that the war was not only for national but for commercial supremacy. He had notified every company incorporated in Australia to wipe out within three months their German shareholders, whether naturalised or not.

Mr. Hughes leaves for England this month.

Prohibited Exports from France.—The French Government has issued an order prohibiting the exportation from that country of magnetos, accumulators, and battery plates.

CORRESPONDENCE.

Letters received by us after 5 P.M. ON TUESDAY cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

Salaries in Power Stations.

So "Chief Assistant," writing in the REVIEW of January 7th, wants to saddle that sorely-tried gentleman, the Minister of Munitions, with some work that he might have done for himself years ago. He wants an adequate living wage and a guarantee that only competent engineers will be employed in electrical power stations. "Chief Assistant" grumbles that the Institution of Electrical Engineers, the Home Office, and Board of Trade have done nothing to help him, but he *hopes* that he will not be overlooked by the Minister of Munitions. Always it seems that a large majority of station engineers expect and wait for some other body to do for them what they can do for themselves.

The managers of the electric supply undertakings do not wait for the I.E.E., the Board of Trade, or the Minister of Munitions to help them; they organise themselves into very strong and formidable associations (quite apart from the Institution, of which most of them are also members) to deal with questions directly concerning them as individuals, to promote or oppose legislation, and generally to look after their own interests. For instance, quite recently there was a little healthy competition amongst the managers for charge engineers and switchboard attendants on account of enlistments, and others leaving to do munition work; salaries had a tendency to rise, and managers either objected to this or thought that, perhaps, the efficiency of their stations might become impaired—it matters little which. This competition was soon stopped by the managers coming to an agreement, through their Association, not to employ each other's charge engineers, etc., without mutual permission. The Munitions of War Act did not apply to the staffs of electrical stations, though the idea was borrowed from Section 7 of the Act. What is good for the managers is better for the staffs under them, and station engineers must follow the lead of their managers and build up a strong and formidable association.

There is at present a great deal of unrest in power stations all over the country. Station engineers' salaries have remained practically stationary, and there is little or no opportunity of bettering their positions by going elsewhere. The limit to the number of those allowed to join the fighting forces of the country has been reached—in fact, I might say, exceeded, as men are being released from military service to take up duties in new stations, and some in old ones.

The cause of the unrest in stations (of which "Chief Assistant's" letter is only a slight indication), besides the greatly increased price of commodities, is due partly to outside influences. Nearly every other section of employés in the engineering industry, with the exception, perhaps, of the technical assistants and draughtsmen, has obtained substantial increases in wages, combined with a great deal of overtime.

The junior technical men are the backbone of the engineering industry. They now know it, and *they have been ignored* by those who are profiting by their energy and zeal. It is easier to withstand a blow than to be ignored; the other sections of the industry cannot be ignored because of their organised strength.

Electricity supply engineers have no excuse, for since January, 1913, there has been an opportunity open to them to help themselves. The Association of Electrical Station Engineers was formed with the avowed object of obtaining better pay and conditions for electricity supply engineers.

If "Chief Assistant" is really serious in advocating an adequate living wage and the employment of competent men only in stations, and is willing to help forward the movement, I can assure him that there is plenty of work before him and any others who care to take the matter up. If electricity supply engineers expect to obtain real assistance from some other source than themselves they are doomed to disappointment.

The Munitions Department has agreed to see that standard rates are paid in all "controlled establishments," and there is no difficulty in getting other Government departments to see that their contractors pay the same. The fixing of agreed rates must be the work of employers' and employés' associations; the question of competency for any particular position is a difficult question, and to tackle it properly some such arrangement must be made as is applied at present to marine engineers. This would mean that legislation would have to be promoted and would entail a large amount of work, and it would cost a deal of money. The work could only be done and the money supplied by an association of the men concerned.

I feel certain that every station engineer knows in his own mind that a strong association is the only solution of the present situation, and I often wonder why so many stand apart and will not help.

The A.E.S.E. still exists, after three years, in spite of adverse circumstances, and has, after much controversy, formulated a definite policy. In various districts where there is a large membership, conditions and wages have been improved by negotiation direct, the Association having on one occasion only to ask the services of the Chief Industrial Commissioner. The whole of the work connected with it is voluntary; there are no paid officials whatever. A monthly journal is issued to members (the work in connection with which is also voluntary), and the Association is anxious to have the help of all in the industry. Those willing to take an active part in the work are wanted more than ever as the Association grows. The subscription is small—10s. 6d. annually—which can be paid half-yearly or monthly as desired. The official policy of the Association is not to resort to strikes, but to make every reasonable application, either by letter or deputation, to attain its objects. Should such efforts fail to obtain satisfaction within six months, then the Association reserves to itself the right to use any methods it thinks proper to enforce arbitration on the questions concerned.

If you approve, join the Association; if you disapprove, join also, and improve it—don't let apathy prevent you from taking any interest whatever. Follow the lead of your managers and build up a strong Association.

W. J. Ebben.
Hon. General Secretary, A.E.S.E.

Leyton, E., *January 10th*, 1916.

[We regret that we have been obliged to condense Mr. Ebben's lengthy communication.—EDS. ELEC. REV.]

Electric Engine Starters for Industrial Motor Vehicles.—Since the fitting of an electric engine starting outfit on American pleasure cars became general, there has been considerable discussion as to the advisability of adding such equipment to industrial motor vehicles. An interesting contribution to the subject has just come to hand from the United States, where the engineering department of the Reo Motor Truck Co., of Lansing, Mich., recently carried out a series of experiments with its new 15-cwt. petrol motor delivery van. It is stated that the results obtained go to show that an engine starting outfit will more than repay its first cost in the saving of petrol effected during the first year of its use, owing to the engine being stopped instead of allowed to run while deliveries are being made. It is also claimed that it will have a marked effect on the cost of upkeep of the vehicle, due to the elimination of the wear and tear of a large amount of idle running. Finally, it may be stated that, as a result of the tests, it has been decided to adopt an electric engine starting set as a standard part of the equipment of the Reo vehicles.

BUSINESS NOTES.

Consular Notes.—BRAZIL.—Considerable extension in the use of electricity in Pernambuco is foreshadowed by the American Consul in that town. The Pernambuco Tramways and Power Co., which some 16 months ago substituted the present electrical system for the long-used mule car system, propose to install an electric light plant. At present trolley wires are extensively tapped to provide street and store lighting. Additional power is also likely to be required for running the elevators in the many new business blocks building or proposed.

CUBA.—According to a recent American Consular report the business outlook in Cuba is very good. Prosperity is especially marked in the sugar trade, and many companies have taken advantage of the present good prices and easily obtained money to replace antiquated machinery with more modern equipment. The quantity of new sugar machinery, which is stated to be all coming from the United States, is referred to as "tremendous." Indications are that more equipment will be purchased during the coming year, the newer mills forcing the older ones, in self defence, to bring their equipment up-to-date. Rumours of new organisations to go into sugar-making may also be heard.

MEXICO.—The American Consul at Chihuahua reports that the power plant of the Cia. Agricola y de Fuerza Electrica at La Boquilla, near Santa Rosalia, Chihuahua, has now been completed and the current made available for use at Parral, in the operation of the cyanide ore treatment plant of a mining company. The current was turned on through the transformer station at Parral on September 28th. At present only 1,000 H.P. is being used.

MANCHURIA.—The American Consul at Harbin, China, quoting the *Novosti Zhizni*, of October 21st, states that a British firm has made arrangements for establishing an electrical plant at Station Handashedzu on the Chinese Eastern Railway, about 170 miles east of Harbin. The capacity of the plant will be sufficient to provide several thousand consumers with electricity and to light the streets of the village.

Book Notices.—*Diesel Engines for Land and Marine Work.* By A. P. Chalkley, B.Sc. Fourth edition. London: Constable & Co. Price 8s. 6d. net.—Owing to the rapid progress in the evolution of the Diesel engine, this work, although first issued at the end of 1911, has been completely revised for the second time in four years. The new material is found mainly in the section dealing with Diesel engines for marine work, a direction in which much work is being done; the illustrations have been nearly doubled in number, new types are described, and an additional chapter on the design of Diesel engines has been inserted. The makers and users of this type of prime mover are fortunate in having at their service so comprehensive and so well illustrated a work on this subject, which occupies a special place in oil engine practice—as is indicated by the fact that an association of users of Diesel engines has been formed to discuss their peculiarities of construction and working. "The Diesel engine," says the author, "is perhaps the most scientifically designed motor in existence," requiring great exactitude in construction and the utmost care in erection, though once in operation it becomes a machine of the greatest reliability. Useful chapters on installing, running and testing the engine are included, and some interesting estimates of initial and working costs, based upon actual installations, are given.

A Text-book of Paper-Making. By C. F. Cross and E. J. Bevan. London: E. & F. N. Spon, Ltd. Price 15s. Fourth edition.—However interesting the details of the art of making paper to those engaged upon it, we cannot suppose that the average electrical engineering reader has leisure to study it except in so far as his profession brings him into contact with it. The points of contact may be multiplied as time goes on, but at present they are few in number, though of considerable importance; they include the electric lighting and driving of the paper mills, the electrolytic bleaching of the paper pulp, and the use of paper in various forms for the insulation of electric cables and apparatus generally, the last being, of course, by far the most important. It is curious that the authors hardly mention the lighting of a paper mill, although the necessity of judging colour correctly would seem to involve the use of electric lighting specially adapted for this purpose at certain stages of the process. A short section on electric power describes the distribution of electrical energy from a central power station to the motors driving the machinery as "the ideal conditions," to which the older mills are being converted. Steam is required for so many purposes in paper mills that the method of using it first in a turbine and afterwards for the manufacturing processes becomes very economical and convenient, and is highly recommended. As regards the third point of contact above-mentioned, the book will be of especial interest to cable-makers and other users of high-class papers, who, as was made evident in the proceedings of the I.E.E. some years ago, have found it necessary to study the constitution of their paper very closely. The book is extremely well printed and illustrated, and, needless to say, is printed on excellent paper.

The Electrical Engineer's Diary. S. Davis & Co. Price 3s. 6d.—This year the Diary is issued in two forms, bound in stiff boards and limp covers respectively. In addition to the usual mass of information which it contains, the following are new features:—A section dealing with industrial lighting in a highly instructive manner; a section on electrical cooking and heating, by Mr. R. S. Downe; a table showing the local lighting hours for every day in the year at 30 important centres in the British Isles. Other additions have been made, and the very useful lists of streets in the metropolitan area in which electricity supply is available have been extended to include certain outlying districts. It is a very useful production.

Willing's Press Guide (125, Strand, W.C.), is, as we have said before, a most handy publication for all who want the names, addresses, and a few other particulars, of newspapers, magazines, &c., conveniently arranged. It has reached its 43rd year, and continues to give full value for the money—1s.

Hazell's Annual for 1916 (Hazell, Watson and Viney, Ltd. London: 3s. 6d. net) will hold the prominent place that its lengthy and efficient record has made for it among the useful annuals which contain so much information that one requires to have at hand. This time it has, among other matters, a complete list of recipients of the Victoria Cross and a Roll of Honour of some hundreds of names of those who, in high circles, have sacrificed themselves in their country's cause during the past year. Statistical information regarding the Colonies and foreign countries, 10 pages devoted to aviation matters, and 20 relating to naval affairs, are given, in addition to the numerous sections dealing with trade, finance, shipping, railways, and so forth.

A copy of the *British Dominions Year Book*, 1916, has been received. It is published by the British Dominions General Insurance Co., Ltd., 1, Royal Exchange Avenue, E.C., and edited by Messrs. E. Salmon and J. Worsfold. It contains a wealth of matter regarding the affairs of the Empire, the Army and the Navy, the war, with maps, badges of rank in colour—indeed, in a few lines it is impossible to indicate the wide scope of the contents. In addition to all this general information, there are articles by many well-known writers, including one by Sir Leo Chiozza Money, M.P., on "A Business-like Empire;" one by Cyril M. Picciotto on "International Law in the Present War;" one on "British Opportunities in Russia," by Louis A. Rojansky; one on "The Economic Outlook for Germany;" and others on science and trade organisation, trade in war-time, and so on. The book is not on sale, but is for presentation purposes.

Colliery Manager's Pocket-Book for 1916. Edited by H. Greenwell. London: The *Colliery Guardian* Co., Ltd. Price 2s. net.—According to the statistics given in this handbook, in 1914 electricity was employed in 1,428 mines (a reduction of 42) to a total of 713,782 H.P., compared with 628,098 in 1913; of this 294,092 H.P. was on the surface, and 419,690 H.P. underground, being used mainly for hauling and pumping. There were four types of electric safety lamps in extended use and five others in small numbers, the total being 75,707 in 1914, compared with 37,823 in 1913—a very notable advance; magnetic locking was employed in 61,772 cases, and lead rivets in 13,787. The electrical section of the book consists mainly of the official memoranda relating to the regulations, and contains too little general information to be of much use; we should think that, in view of the increasingly important part played by electricity in mining nowadays, the section might be greatly increased with advantage. The pocket-book appears to be indispensable to the colliery manager.

The Practical Electrician's Pocket-Book and Diary for 1916. Edited by H. T. Crewe. London: S. Rentell & Co. Price 1s. net.—This is now in its 17th edition; by condensation and the omission of obsolete matter, room has been made for new sections dealing with electric pumping plant, drills, blowers, and lifting magnets, telephones and shaft signals, bells and indicators, and battery vehicles. It is a useful little book.

The Christmas number of the *Wileroid* (the journal of the Willesden Works employés of the British Thomson-Houston Co., Ltd.) excels even its predecessor, the first issue of the journal, in interest and mirthfulness. It contains lively articles from the front, a variety of essays of strictly local and professional bearing, and sundry miscellaneous items, many of which are very clever.

Lektrik Lighting Connections.—Messrs. A. P. Lundberg & Sons' well-known booklet (price 6d. net, 7d. post free), is now in its fourth edition and its 35th thousand; it occupies a field entirely its own, and must unquestionably be of great use to wiring contractors and wiremen. A lengthy list is given of the holders of certificates in the advanced grade of Messrs. Lundberg's examinations, and a new section on automobile controls has been inserted.

We have received a copy of Part I of "Russian Reading Made Easy," also one of "Russian Grammar Simplified." Both are issued by Hugo's Language Institute, Gracechurch Street E.C.

"Post Office Electrical Engineers' Journal," Vol. VIII, part 4. January, 1916. London: H. Alabaster, Gatehouse & Co. Price 1s. net.

"*Journal* of the Institution of Electrical Engineers." Vol. LIV. No. 254, January 15th, 1916. London: E. & F. N. Spon, Ltd. Price 3s. 6d.—This issue contains Mr. J. E. Kingsbury's address to the Students' Section, and the following papers:—"Ignition of Explosive Gas Mixtures by Electric Sparks," by Mr. J. D. Morgan; "Electric Heating," by Mr. G. Wilkinson; "Resistance of Heat-treated Copper-Zinc-Nickel-Alloys," by Mr. F. C. Thompson.

"*Proceedings* of the Physical Society." Vol. XXVIII. Part 1. December 15th, 1915. London: The *Electrician* Printing and Publishing Co. Price 4s. net.

"*Journal* of the South African I.E.E." Vol. XIV. No. 5. December, 1915. Johannesburg: The Institute. Price 2s.

"Spons' Architects' and Builders' Pocket Price Book for 1916." By C. Young and S. M. Brooks. London: E. & F. N. Spon, Ltd. Price 2s. 6d. net.

Meter Prices.—THE BASTIAN METER CO., LTD., announce that the high cost of labour, raw material, carriage, and other items, has compelled them to revert to pre-war prices for their Bastian meters. The reduction announced in July, 1914, is, therefore, no longer in force.

Catalogues and Calendars.—DIAMOND COAL CUTTER Co., Wakefield.—Wall calendar with monthly date slips for 1916.

MESSRS. PIRELLI, of 144, Queen Victoria Street, London, E.C., have sent us a calendar for the year with a block of daily date slips with bold figuring on a metal background. Above the block there is a most pleasing design in appropriate colouring, in which a Pirelli tire is speeding the flags of the Allies on to victory.

From MESSRS. JOHNSON & PHILLIPS, LTD., of Charlton, S.E., we have received a most welcome and handy vest-pocket diary and engagement book (black and gold) containing an insurance coupon. The company have also prepared for their friends a large desk blotting pad with a diary interleaved with blotting paper, also a block of spaces for daily engagements at the left hand side, while on the right there is a block of memoranda slips.

THE NAVY EMPLOYMENT AGENCY, of 25, Victoria Street, S.W., have favoured us with one of their "Clyde" calendars with date indicator—a device which we have found most useful. The agency was founded for the purpose of finding employment for men of the Royal Navy and Marines on their leaving the Service; amongst its *protégés* are engineers and electricians. It is an admirable institution, and though at present, owing to the war, it has very few men on its books, it is hoped that on the termination of hostilities our readers will, as far as possible, give employment to the men who have so zealously guarded our shores.

MR. C. H. JEFFCOAT, 18, Ranelagh Gardens, Hammersmith, London, W.—Illustrated leaflet relating to the "Lamlok" electric lamp-locking ring.

MESSRS. ALEX. HAWKINS & SONS, London Road, Southwark, S.E., have issued a small and attractive wall calendar for 1916 with a coloured print entitled "First Aid to the Injured," beneath which are small monthly date slips.

MESSRS. AUSTIN WALTERS & SON, 57, Lower Mosley Street, Manchester.—20-page catalogue of "Signs for All Trades," showing a number of designs of electric signs for use outside cafés and restaurants, hotels and shops, garages and picture theatres; also a selection of artistic window signs, interior theatre signs, wood-letter signs, electric sign flashers, and electric time switches.

THE LIVERPOOL ELECTRIC CABLE CO., LTD., Bootle, Liverpool, have issued a serviceable wall calendar with a set of monthly date slips fixed beneath a bird's-eye view of the works.

BOSTON GEAR WORKS, Norfolk Downs (Quincy), Mass.—90 pp. illustrated pocket catalogue and price list of Boston gears.

MESSRS. LE CARBONE, 17, Water Lane, Great Tower Street, London, E.C.—Circular tabulating particulars and schedule of qualities of their carbon brushes for dynamos and motors.

Bankruptcy Proceedings.—HERBERT PAGE, electrical engineer, trading as Smeeton & Page, at 63, Queen Victoria Street, E.C., and residing at 32, Marlborough Road, Chiswick.—An application was made on January 11th, to Mr. Registrar Linklater, at the London Bankruptcy Court, for an order of discharge. Mr. Egerton S. Grey, Official Receiver, reported that the failure occurred in July, 1915; the bankrupt returned ranking liabilities amounting to £2,157, but the proved and provable debts totalled £2,292; the assets valued by the bankrupt at £176, had produced only £79, owing to the excessive value placed by the bankrupt on his office furniture, plant and stock-in-trade, which were subject to a claim for rent, and from which nothing could be recovered from the estate. A dividend of 6¾d. in the £ had been paid on proofs of debt amounting to £2,232. The failure was attributed to loss on trading, excessive drawings, and interest on borrowed money. As offences the Official Receiver reported (1) insufficiency of assets to equal in value 10s. in the £ on the amount of the unsecured liabilities; (2) trading with knowledge of insolvency; and (3) a previous arrangement with creditors. His Honour upheld the report and suspended the discharge for two years. Order entered accordingly.

HARRY A. WEST, described as of 114, Chancery Lane, W.C.—At a sitting of the London Bankruptcy Court, held before Mr. Registrar Linklater, bankrupt applied for an order of discharge from proceedings instituted in September last. Mr. Egerton S. Grey, Official Receiver, reported that the proved and provable debts amounted to £1,015, and the assets had realised only 13s. 6d. The bankrupt was an insurance clerk with a salary of £370 per annum, and he was willing to set aside £75 a year for the benefit of the creditors. It appeared that in June, 1911, in order to set up his only son in business, the bankrupt purchased, for £175, the goodwill, stock and effects of an electrical engineer's business at 55, Old Dover Road, Blackheath, and, his son being a minor, the bankrupt purchased the business in his own name. He was in debt to the extent of £100 at the time, and borrowed £175 with which to pay for the concern. The business was unsuccessful throughout, owing in a great measure to the mismanagement of the son. The bankrupt borrowed further sums from time to time for the purposes of the business, and eventually the lender sued him for repayment, obtained judgment, and made him bankrupt. The Official Receiver reported that the bankrupt had been guilty of misconduct in relation to his affairs by obtaining from the petitioning creditor an advance upon the security of a charge over a certain interest to which his son was entitled, without disclosing the fact that such interest was already mortgaged. Insufficiency of assets to equal 10s. in the £ on the amount of the unsecured liabilities was also reported by the Official Receiver, and Mr. E. W. Hansell, on behalf of the petitioning creditor, opposed the discharge on the ground that the bankrupt had entered a frivolous and vexatious defence to an action. Mr. Storry Deans appeared for the bankrupt in support of the application, and consented to an order for his client to set aside £100 per annum for the benefit of his creditors. His Honour gave the bankrupt liberty to again apply to the Court regarding his discharge, when he had paid the creditors 10s. in the £. Order entered accordingly.

JAMES PROCTOR KYD CLARK, electrical and mechanical engineer, Hythe Road, Willesden Junction, N.W.—At the London Bankruptcy Court on January 12th, an application was made before Mr. Registrar Hope, for an order of discharge. Mr. E. Leadham Hough, Senior Official Receiver, reported that the applicant failed in March last, with provable debts £1,951, and no assets whatever. He traded from 1895 till November 4th, 1914, at first with a partner, but subsequently in 1903 by himself. In 1902 they appointed a gentleman, of whose estate the petitioning creditor became administrator, their selling agent in Russia, and he so acted until his death in September, 1910. Disputes afterwards arose between the petitioning creditor and the bankrupt on the accounts between the parties, with the result that an action was tried and judgment given against the bankrupt for £1,672, and costs taxed at £273. In November, 1914, the bankrupt transferred his business to his manager in consideration of £200 cash and an undertaking to discharge liabilities of the business to the extent of £732, but not the debt to the petitioning creditor. The assignment to the purchaser comprised stock taken over at the price of £911; stock and work in progress taken over at £360; office furniture, £50; book debts amounting to £1,408, and taken over at £909; cash, £34; the lease and goodwill of the business and many other assets for which nothing was paid by the purchaser. The Official Receiver submitted that the sale by the bankrupt of his business was not *bonâ fide* on his part, but was made for the purpose of depriving the petitioning creditor of the benefit of any judgment which he might recover against the bankrupt. As offences were alleged (1) insufficiency of assets to equal in value 10s. in the £1 on the amount of the unsecured liabilities; and (2) misconduct in having denuded himself of assets in order to defeat the petitioning creditor's claim. Mr. Tindale Davis appeared for the petitioning creditor, and the learned Registrar, in suspending the discharge for three years, remarked that it was clearly a case of wrong-headed vindictiveness on the part of the bankrupt.

G. J. T. J. PARFITT, consulting electrical engineer, Keynsham.—Application for debtor's discharge is to be heard, at Bristol, on February 25th.

WILLIAM CAREY WILD, electrical engineer, 57, Rhodes Street, Halifax, Yorks.—The public examination of the above debtor was held on January 14th, at the County Court House, Prescott Street, Halifax, when the liabilities were stated at £126, and the deficiency at £55. The debtor stated that two years ago he removed to larger premises, thereby increasing his expenses, but since the outbreak of war his trade had fallen off. The debtor was allowed to pass.—February 2nd is the last day for the receipt of proofs for dividend, by Mr. W. Durrance, Official Receiver, 12, Duke Street, Bradford.

Dissolutions and Liquidations.—ILKESTON MOTOR AND ELECTRICAL ENGINEERING CO., LTD.—This company is winding up voluntarily, with Mr. A. Boaler, of Nottingham, as liquidator.

EASTON & CO., LTD.—A meeting is called for February 15th, at 11, Ironmonger Lane, E.C., to hear an account of the winding up from the liquidator, Sir W. B. Peat.

EASTON, ANDERSON & GOOLDEN, LTD.—A meeting is called for February 15th, at 11, Ironmonger Lane, E.C., to hear an account of the winding up from the liquidator, Sir W. B. Peat.

CICOY MAGNETO CO., LTD.—Mr. E. H. Hawkins, 4, Charterhouse Square, E.C., has been appointed liquidator, to act jointly with Mr. W. G. Newman.

ROYLE ENGINEERING CO., engineers, Croydon.—Messrs. H. W. Robinson and C. L. Lloyd have dissolved partnership. Mr. Robinson will attend to debts.

Electric-Light Switching Competition.—MESSRS. A. P. LUNDBERG & SONS, of 477-489, Liverpool Road, London, N., inform us that their next competition or examination will be held next month. Full particulars, including the problems, may be had on application to them, no charge being made. We have, on various previous occasions, commented on the practical nature of the subject dealt with, and most of our readers will have noticed the periodical announcements of "results" in this Journal. Those who are still more or less in the dark as to what it is all about should find full enlightenment in the aforementioned "particulars." These will be sent to overseas applicants, as well as to those at home.

For Sale.—The Dunfermline Co-operative Society has for disposal its present power station plant and motor equipment, consisting of two 75-KW. sets, direct-coupled Belliss & Morcom engine and Crompton generator, switchboards and instruments, Babcock boiler, feed pump, &c; also 10 motors, from 2 to 30 H.P.

The L.C.C. invites tenders for the purchase of one 3,500-KW. steam alternator, 6,600 volts, 25 periods per second; the set consists of two engines, one on each side of alternator, complete with condenser and air pump. Halifax Corporation has for sale two 200-KW. Parsons' D.C. turbo-generators and three 100 KW. E.C.C. rotary converters. See our advertisement pages to-day.

Trade Announcement.—THE WILSON APPARATUS CO. announce that their business is now being carried on under the style of the "Globe Radio-Apparatus Co," with head office at 18, Old Broad Street, London, E.C., where all communications should be sent. For the present the works address will remain at Finchley Lane, Hendon, N.W.

Social.—On Friday, January 7th, the FOSTER ENGINEERING CO., LTD., held their annual fancy dress dance at the Masonic Hall, Wimbledon, S.W. About 180 persons were present, all, with about six exceptions, being in costume. A series of topical verses were set to a well-known tune by Mr. Lazenby, a director of the company. After supper the prizes were presented by Mrs. Lazenby.

Patent Restoration.—Letters Patent No. 9,339, of 1900, granted to G. de Bechi and R. W. Rücker, for "Improvements relating to the treatment of complex sulphate ores," has been granted.

Board of Trade Inquiries.—Recent inquiries received by the B. of T. Commercial Intelligence Branch are for names of British makers of the following:—Celluloid, suitable for accumulator cells; electric pocket lamps and bulbs; centrifugal pumps, made in lead, for pumping acid.

LIGHTING AND POWER NOTES.

Barnsley.—STREET LIGHTING.—The Electricity Committee has decided to restore half-lighting throughout the borough.

Brierfield.—The L.G.B. has refused to authorise the borrowing of further capital moneys for the electric lighting undertaking under the sanction previously given.

Burton-on-Trent.—PRICE INCREASE.—The T.C. has been informed that there would shortly be a revision of the electricity charges, both for lighting and power, owing to the increasing cost of fuel. It was anticipated that by March next the increased cost would amount to £2,000.

Canada.—By the purchase of the Gres Falls power site and the recent agreement with the Laurentide Power Co., the Shawinigan Water and Power Co. will practically control the most important water developments on the St. Maurice River, and will possess, it is stated, one of the greatest aggregation of power resources under one control in the world. The storage dam now being constructed at the mouth of the Manouan River will considerably increase the water facilities of the Shawinigan Co. The Gres Falls are about four miles below Shawinigan, and are capable of developing between 60,000 to 75,000 H.P.

Last month the Hydro-Electric Power Commission of Ontario placed in operation the generating plant at Eugenia Falls, on the Beaver River, 80 miles from Owen Sound, the installation consisting of two 2,250-H.P. Escher-Wyss turbines coupled to 1,200-K.V.A. generators. Power is generated at 4,000 volts and stepped up to 22,000 volts for distribution to Owen Sound, Shelburne, Durham and Mount Forest. The load on the first day of operation reached 856 KW., and at the present time 1,500 KW. represents the daily maximum requirements.—*Canadian Electrical News.*

Ceylon.—The final taking over of the plant and consumers by Government, from the Board of Improvement, Nuwara Eliya, the mountain capital of Ceylon, was to be effected on January 1st, 1916. The new generator and turbine, which were landed during the middle of the year, have now been erected; they were tested recently and are working satisfactorily. The question of lighting has been deferred.—*Indian Engineering.*

Chippenham.—STREET LIGHTING.—The T.C. has decided to call upon the Electricity Co. to complete the contract for the public lighting at Lowden without further delay.

Continental.—ITALY.—A grant of water on the River Verdura, with a view to the construction of a hydroelectric station and irrigation works, has been sanctioned by the Prefect of the Province of Girgenti, at the instance of the engineer, Giuseppe Patane, of Catania.

Downham Market.—PROPOSED E.L.—The local gas company has offered to obtain the necessary powers to supply electricity if wanted in the area. The Council is negotiating with Mr. Best, of Bradford, in regard to such a scheme.

Durham.—During the recent gale a large steel tower at the electric station, Yerrington Lane (County Durham), was blown down. The station stands close to the North-Eastern Railway Co.'s main line between Spennymoor and Ferryhill, and the structure which came down was about 80 ft. high. It just missed the railway by a few yards, whilst an adjoining signal cabin narrowly escaped.

Glasgow.—NEW PLANT.—At the last meeting of the Electricity Committee the engineer submitted a report relating to the existing generating plant, from which it appeared that he had only managed to meet the demands made for electricity during the present winter by overloading the generating plant at the Port-Dundas and St. Andrew's Cross stations, and by taking 3,600 H.P. from the Pinkston generating station of the tramways department; that he had still to connect three large factories, which are to be used later for the manufacture of engineering material; and that the margin of power for supply provided by the existing generating plant is much too small. The Committee, after considering its report, was of opinion that additional plant ought to be ordered without delay, and agreed to recommend that tenders for two 6,000-KW. turbo-alternator sets be obtained and submitted for consideration.

Gloucester.—The Electricity and Light Railways Committee reports that for November the output of electricity was 209,511 units against 187,009 in the corresponding period of last year. On the light railways for the six weeks ended December 29th, the receipts showed a decrease of £18 compared with last year, due mainly to increased wages.

Hereford.—LOAN REFUSED.—The L.G.B., in response to a repeated application for sanction to a loan for the provision of additional plant at the electricity works, has again refused, on the ground that the provision of additional plant at the present time is not a matter of pressing necessity, either on the grounds of public health or on account of war requirements. Under these circumstances no applications for new supplies or for the extension of any existing supply will be entertained. The sum required is from £8,000 to £10,000.

Horbury.—The U.D.C. has consented to the use of overhead lines in the district by the Yorkshire Electric Power Co., subject to the substitution of underground cables across Dudfleet Lane on receipt of six months' notice, and the company has accepted the condition.

London. — ST. MARYLEBONE. — The L.C.C. has sanctioned the borrowing of £3,800 for electricity mains and services. The Electricity Committee recommends that the charge to the Port of London Authority for the hire of two spare sets of 500-KW. turbines for cold storage purposes be £20 per week.

The Committee recommends the Council to protest against the Government introducing measures to effect the pooling of private-owned railway wagons, as the supply of coal to the electricity works would be made more difficult.

The revenue account of the Council's electricity undertaking for the September quarter, 1915, shows a gross revenue of £33,811, and expenditure £19,174, leaving a balance of £14,367 available for loan and special charges, an improvement of £347 compared with the corresponding period of 1914. The number of units sold shows a decrease of 5·9 per cent.; during the June quarter the decrease was at the rate of 9·6 per cent., and the improvement during the September quarter has reduced the diminution of sales over the half year to September 30th, to 7·93 per cent. on the 1914 totals. Since September 30th the daily output returns, with few exceptions, show a marked increase over the corresponding days of last year, the cumulative effect of which is to reduce the above percentages of 9·6 and 7·93 to about 3 per cent. for the portion of the financial year to date. The generation expenses were £7,581, as compared with £6,584 and £7,546 for the corresponding periods of 1914 and 1913 respectively. The average price paid for coal during the quarter was 20s. 2d., as compared with 14s. last year. The improvement in trading and the higher prices obtained, have enabled the enhanced coal prices, £1,705, to be met, the cost of allowances granted to employés on national service, £994, the cost of guarding the works, £123, and the extra cost of materials generally, and to leave a balance larger than last September by £347 to meet the capital and special charges for the year ending March next.

SOUTHWARK.—The accounts of the Borough Council's electricity undertaking for the year ended March 31st, 1915, show a deficit of £6,410.

POPLAR.—According to the report of Mr. Bowden, chief electrical engineer to the B.C., the net surplus on the electricity undertaking for the September quarter was £2,071, as against £1,286 for the June quarter, making a total for the half-year of £3,358. This figure compares with £2,408 for the corresponding period last year, and therefore shows an increase of £950. Mr. Bowden adds that on account of increased prices £2,835 extra was paid for coal; that the revenue was reduced by £600, owing to the Stepney Council not taking a stand-by supply this year; and that other extras paid amounted to £436, while the reduction in lighting rates represented a reduction of over £500 in revenue, in view of which the result is a remarkable one.

HAMMERSMITH.—STREET LIGHTING.—The Special Committee appointed to consider the question of the allowance to be made by the Electricity Committee in consequence of the restricted public lighting, recommends that £2,500 be deducted for the financial year ending March 31st next, and that an allowance at the same rate per annum be made subsequent and until otherwise ordered by the Council.

BERMONDSEY.—Having regard to the fact that the loans for meters, ordinary mains and for services have been overspent to the extent of £1,610, the B.C. is recommended to apply to the L.C.C. for sanction to, and the advance of, a further loan of £3,000.

FULHAM.—The Law and Parliamentary Committee recently claimed £875 from the coal contractors for loss occasioned by non-delivery of coal; the matter has now been settled by the contractors agreeing to reduce their account from £629 to £500, and to release their bonds.

PRESSURE TESTING STATIONS.—The Hammersmith Council at its last meeting decided to support the suggestion of the Hackney B.C. that the periodical inspection of pressure testing stations carried out by the L.C.C. should be suspended during the war. The Electricity Committee considers that the undertakings might be saved the testing fees, and the services of the official be rendered available for work of a more useful character

King's Lynn.—PRICE INCREASE.—Owing to the increased cost of fuel, &c., the T.C. has advanced the charges for current for power by another 5 per cent.

Luddenden Foot.—A conference is to be held between the chairman of the U.D.C. and the borough electrical engineer of Halifax in regard to the supply of electricity.

Middlesbrough.—Fire broke out in the generating plant at Nunthorpe Hall recently, and before the arrival of the Middlesbrough fire brigade, £200 worth of damage was done.

According to Mr. R. H. Scotson, borough electrical engineer, the total estimated revenue of the electricity department for December was £3,268 as against £3,204 for December of the previous year, and the total estimated profit for the month was £2,069, compared with £1,857. An inquiry in regard to an explosion at an electricity manhole was left by the T.C. with the borough engineer and the engineer to the Post Office, whose main was concerned.

Mirfield.—The U.D.C. has applied to the B. of T. for consent to use overhead transmission, at 200 volts, for the purpose of supply under the order of 1899.

Newport (Mon.).—The Electricity and Tramway Committee reports that the Gas Co. demanded that an inquiry should be held by the L.G.B. on the question of the supply of electricity to Maeglas, which is outside the borough. The inquiry was held last week, with the result that the B. of T. has intimated that electricity should be supplied to the new works.

Northallerton.—STREET LIGHTING.—It was reported to the U.D.C. that owing to restricted lighting, the street E.L. account for the past quarter amounted to only £46 against £178 in the corresponding period of last year.

Pendlebury.—A generating plant is being provided at the Acme spinning mill to provide power for driving that mill and the adjoining Albion mill. The Acme mill was the first spinning mill in Lancashire to be electrically driven.

Perth.—The electricity department came to the assistance of the city the other day on the occasion of a breakdown at the gasworks. In connection with the matter, Mr. J. Lambert, Corporation electrical engineer, has been asked to report upon the whole of the electric appliances in use at the gasworks, and advise specially as to the obtaining of duplicates to replace any parts that may go temporarily out of order or may be worn out.

Slaithwaite.—PROV. ORDER.—The U.D.C. has decided to apply for the date of the electricity order to be extended for a period of 12 months after the end of the war.

Southend-on-Sea.—The T.C. is recommended to arrange for the installation of a new automatic electric starting apparatus for the sewage pump in Hamstel Road. Messrs. Callender have written the Electricity Committee asking it to take delivery and pay for the cable ordered in connection with the proposed supply of current in the Leigh area, the delivery and payment having been delayed in compliance with the L.G.B.'s embargo on capital expenditure. In view of the largely increased price, which it would probably have to pay for the cable at a later date, the Committee has resolved to authorise the clerk to inform Messrs. Callender that the Council will take delivery of and pay for the cable in April next. The Committee decided that in the event of the Corporation being permitted by the L.G.B. to install one or more of the engines in the Leigh sub-station, application be made to the Board for authority to raise the cost of the cable under the sanction of December, 1914, authorising a loan of £18,000 for cables, &c. (the cost of the cable in question being included in such application), and that in the event of the Corporation not being permitted to equip the sub-station the cost of the cable be paid out of revenue.

Sowerby (Thirsk).—STREET LIGHTING.—The Electric Lighting Co. has offered an allowance of £30 off the lighting account providing there is no alteration in the lighting conditions. It was pointed out that the contract was for three years, subject to the amount being allowed by the parish meeting, and the amount the meeting would have been asked to raise for the current year was £105. It was agreed to accept the company's offer.

Surbiton.—E.L. TRANSFER.—The U.D.C. has now received the sanction of the B. of T. for the transfer of the E.L. undertaking to Messrs. Callenders.

Swindon.—The T.C., having received an application for a supply of current to Broome Manor, for lighting and power, has referred the matter to the Electricity Sub-Committee. To comply with the request the overhead line will have to be extended from Broome sewage works, at an estimated cost of £275.

Swinton and Pendlebury.—The D.C. has decided that the agreement with the Lancashire Electric Power Co. for the supply of electricity shall be extended to the year 1923. It is stated that the effect of this will be to lower the price of current to the Council.

West Bromwich.—The T.C. has entered into an agreement with the Oriental Tube Co., Ltd., to supply a minimum of 80,000 units per annum for a period of years.

Wolverhampton.—PROPOSED LOAN.—The Corporation proposes to borrow £1,780 for mains extensions in connection with the supply of electrical energy to local works.

TRAMWAY and RAILWAY NOTES.

Ashton-under-Lyne.—WAGE INCREASE.—As the result of the recent arbitration between the Corporation and the tramway employés, increases of wages have been awarded to the men as follows:—Motormen and conductors receive an increase of $\frac{1}{16}$d. per hour, and shedmen ¼d. per hour, the increases to date from October 4th. The motormen and conductors working on the Manchester section receive the following increases for the duration of the war:—1s. per week to employés up to 21 years of age, and 2s. per week to those above that age. The wages of inspectors were increased by 1s. 6d. per week.

Birmingham.—FEMALE LABOUR.—The Tramways Committee reports that there were now 700 women acting as conductors on cars in the city, and, generally, their work gives satisfaction. About 50 professional and business men are acting as motormen on cars during the week-ends.

Bolton.—FEMALE LABOUR.—The Tramways Committee has authorised the tramways manager to employ as many women car conductors as he deems necessary, and it has been decided to adopt a uniform similar to that used by the women conductors at Oldham.

Chesterfield.—The T.C. has decided to apply for the tramways undertaking to be a "controlled" establishment. An application for the women tramway conductors to be paid the war bonus given to male employés, has not been granted, as they commenced duties after the outbreak of war at the maximum rate of pay.

Continental.—SPAIN.—RAILWAY ELECTRIFICATION.—The establishment of interurban electrical railways in Spain is hindered by unfavourable geographical conditions. The country consists for the most part of a lofty plain, sparsely populated, sloping towards the coast, and the railway network in conjunction with the cart roads suffices for the insignificant traffic. Only on the coast, which is thickly-populated, are there interurban railways. According to the report of a German engineer, Herr W. Reinart, in the *Elektrische Kraft und Betriebe*, the greater part of these, some 15 lines, with a total working length of 295 km., are of 1 metre gauge. One of these railways, running from Pampeluna to Sanguess, 18 km., is worked by single-phase current, at 6,000 volts and 25 cycles; all the others employ continuous current at 500-600 volts, with the exception of the Viga-Mondariz line, 42 km. in extent, which is still under construction, and which will employ continuous current at 1,200 volts. Another line intended for working with continuous current at the same pressure, the Barcelona-Sabadel-Tarasa, is now under construction; and three lines running out of Bilba, of an aggregate length of 80 km., will work with current at 500 600 volts. Of ordinary electric railway lines the Gergal-Santafé-Mondigur (near Almeria), with a gauge of 1·66 m., is the only one in use. It is engaged almost wholly in the transport of ore on a gradient, and with a view to utilising regenerative methods, the three-phase system has been chosen. The trains are drawn by two locomotives of 52 tons weight each, with two 160-H.P. motors each. A more important long-distance line, whose electrification was under consideration just before the outbreak of the war, is that which connects Huelva with the famous Rio Tinto copper mine; this line, devoted almost exclusively to the carriage of ore, is 80 km. long, and has a gauge of 1·30 m. For its working it is intended to use three-phase current at 3,000 volts and 50 periods; the locomotives are fitted with two motors of 600 H.P. each. A Commission nominated by the Spanish Government is at the present moment occupied with a scheme for an express electric line from Madrid to the French frontier, whose termination will probably be at the new Somport tunnel, which passes through the Pyrenees.—*Revista Tecnica d'Elettricità.*

ITALY.—The Società Anonima dei Tramways Florentine has applied for authority to build and work new electric tramways from a point in the city to La Lastra.

Application has been made for a concession for the construction and working of a short line of metre-gauge electric tramway to connect the town of Todi with the Todi-Porte Nara railway station.

SWITZERLAND.—The Swiss State Railway authorities have decided to commence the work of electrifying the Gothard Railway, a start being made with the Erstfeld-Bellinzona section of the line. For the current year provision has been made for the expenditure of £120,000 on the work; of this, £56,000 is for the Amsteg power station, £52,000 for the Ridom station, and £12,000 for rolling stock and the construction of a short trial section. The provisional estimates provide for the expenditure of £380,000 in 1917, £540,000 in 1918, £440,000 in 1919, and £60,000 in 1920, the total cost being thus £1,540,000.

Dudley.—TRAMWAY ACCIDENT.—On Sunday evening last a serious tramway accident occurred on the Dudley—Wednesbury route, owing to a car carrying 30 passengers running away down hill, without the driver, and subsequently jumping the points and overturning across a footpath. Sixteen passengers were injured, and one of these has since died of injuries received. Apparently the car was at a terminus which was on a slight gradient, and, the brakes having been applied, the driver went to meet a Birmingham car, by which his tea was sent up. The conductor, who remained on the car, changed the trolley-pole, and,

thinking the driver was at his post, rang the bell and released the brakes. The car then started, and he commenced to take fares, being unaware of the position of things until his attention was drawn to the matter by a passenger; his subsequent efforts to apply the brakes were too late, as the car left the track and overturned, as mentioned. This accident resembles very closely that which occurred at Barnsley on December 2nd, 1914, and on which Col. von Donop subsequently reported, his findings being given in our issue of February 5th last year.

Edinburgh.—A Sub-Committee has been asked to report fully on the state of the tramways undertaking, in preparation for the Corporation taking it over; the question of procedure when the lease expires will also be considered. Mr. Newington, city electrical engineer, is to report on the advisability of electrically lighting the cars.

Glasgow.—A sum of £490, including a grant of £50 given by the T.C.'s Departmental Committee, has been collected in boxes in the cars on the Glasgow system, for supplying seasonable comforts for the ex-members of the department who joined the 17th Batt. of the H.L.I., which is mainly composed of Corporation ex-workers. A number of parcels have already been sent to France, and, under a novel scheme which has been introduced, a considerable portion of the fund has been invested in wool, with which the wives of the men, the women employés of the department, and others, are engaged in knitting comforts for the men in the trenches.

L. & S.W. Railway Electrification.—According to the *Daily Express*, Mr. H. Holmes, superintendent of the L. & S.W. Railway, states that the new service of electric trains between Kingston and Waterloo will be brought into operation on Sunday, January 30th.

Middlesbrough.—RAILLESS TRACTION.—The non-delivery of the cars is responsible for the delay in the opening of the railless traction system which will connect up Middlesbrough with the Eston district lower down the Tees bank. Owing to Government contracts, the delivery of the cars is not expected for two or three months.

Stretford.—Complaint has recently been made of the inadequacy of the car service to Trafford Park from Manchester and Salford. The question was raised at a meeting of the Stretford D.C. last week, and the clerk was instructed to draw the attention of the Manchester and Salford Corporations to the matter, and to express the hope that an improved car service might be arranged.

U.S.A.—The first actual tests of the Chicago, Milwaukee and St. Paul Railroad Co.'s new electrified mountain divisions have just been made by officials and directors of the system, who toured the completed sections of the 400-mile electrified district in three special cars drawn by one of the new 260-ton, 3,000-volt electric locomotives. After making passenger-train tests, running at all speeds up to 70 miles an hour, the officials witnessed tonnage tests, in which locomotives used on passenger trains, equipped for heavy hauling instead of speed, pulled 2,500 tons at a uniform speed of 16 miles an hour. It is expected that the all-steel transcontinental trains of this company will be operated electrically over the continental divide at an early date. While the cost of the work has been $20,000,000, the saving in fuel, in increased hauling capacity, in maintenance of speed schedules and in mechanical upkeep will be so large that a return of 20 per cent. a year on the investment is anticipated. The regenerative braking device in the equipment of the electric locomotives proved under the tests to be completely successful.—*Electrical World.*

TELEGRAPH and TELEPHONE NOTES.

Cables in Code.—The Postmaster-General announces that the Rubber edition of Broomhall's "Imperial Combination Code" has been added to the list of codes authorised for use in foreign telegrams, except in telegrams to Argentina, Brazil, Paraguay, Uruguay and Honduras.

Marconi v. Telefunken.—The Standard Oil Co., of New Jersey, has decided to remove the Telefunken wireless apparatus from 22 of its ships, and to substitute the Marconi system, with American operators. A contract has been made with the Marconi Wireless Telegraph Co. of America to this end, and is regarded by the Marconi Co. as a very important transaction.

CONTRACTS OPEN and CLOSED.

OPEN.

Australia.—February 18th. Melbourne, Brunswick and Coburg Tramways Trust. Six radial trucks.*

April 15th. P.M.G. Common-battery multiple switchboard, or automatic or semi-automatic switchboard, and associated apparatus. See "Official Notices" December 31st.

BRISBANE.—February 28th. Deputy P.M.G. Gas engine, generator, battery, power board, &c., for the Post Office, Townsville, Queensland. (Schedule No. 370.) High Commissioner's Office, 72, Victoria Street, S.W.

MELBOURNE.—February 16th: 51 electric staff instruments. February 23rd: Two commutator slotting machines, for the Victorian Railway Commissioners.*

February 2nd. Agent-General for Victoria. Fuse distribution boxes and fuses, for the Victorian State Railways. See "Official Notices" January 14th.

SYDNEY.—February 7th. Metropolitan Board of Water Supply and Sewerage. For No. 1 pumping station at Ultimo. Two centrifugal pumps and electric motors (4,000 gallons per minute each), switchboards, starters, &c. Contract No. 1,301.*

February 28th. Municipal Council. Tenders for induction regulators. Specifications (11s. 6d.) from the Electric Light Department, Town Hall, Sydney.

May 3rd. N.S.W. Railways and Tramways Department. One 2,500-KW. turbo-alternator, for Zara Street, Newcastle, power house. Specifications (20s.) from the Engineer's office, 61, Hunter Street, Sydney.

Croydon.—January 24th. Corporation. Stores for the Tramways Department. Particulars from the Manager, Tramways Department, Thornton Heath.

Doncaster.—January 24th. Relaying portion of the permanent-way, Nether Hall Road, for the Corporation Tramway Department. Mr. R. E. Ford, Acting Borough Engineer (returnable deposit of £1 1s.).

Dublin.—January 21st. Corporation. Arc lamp carbons. See "Official Notices" January 14th.

Eccles.—X-ray apparatus at the Eccles and District Hospital, for the Board of Management.

Halifax.—February 14th. Corporation. Twelve months' supply of electric lighting fittings and accessories, cables, telephone wire, meters, &c. See "Official Notices" to-day.

London.—ISLINGTON.—January 21st. B.C. Twelve months' supply of engine-room stores, electrical fittings, meters, cables, &c. See "Official Notices" Dec. 31st.

BERMONDSEY.—February 10th. B. of G. Twelve months' supply of electric lamps. Forms of tender from Mr. E. Pitts Fenton, Clerk to the Guardians, 283, Tooley Street, S.E.

FULHAM.—The Electricity and Lighting Committee recommends that no annual contracts be entered into for the supply of electrical and engineering stores, but that the borough electrical engineer be authorised to purchase in the open market when required.

HAMMERSMITH.—The Electricity Committee recommends the B.C. to invite tenders for 12 months' supplies of electric light sundries, insulated wires, packing and jointing materials, joint-boxes and connections.

New Zealand.—AUCKLAND.—February 23rd. City Council. Centrifugal pumping electric motors, and automatic starting and controlling apparatus, for the four city pumping stations. Specifications from the office of the Water Board, Town Hall, Auckland.

DUNEDIN.—May 17th. City Council. (1) Tramcar bodies; (2) electrical equipment. Plans, &c., from the Town Clerk, Dunedin.

RAETIHI.—March 14th. Town Board. 40-H.P. hydro-electric generating set, switchboard, &c. Plans and particulars from Messrs. H. W. Climie & Son, Raetihi.*

WELLINGTON.—March 8th. Public Works Office. One 3,000 KW. generator and one 4,300-H.P. water turbine, at Lyttelton, for the Lake Coleridge electric power scheme. Specifications, &c., may be consulted by British firms at the office of the High Commissioner in London for New Zealand, at 13, Victoria Street, S.W.

Pembroke (Dublin).—February 7th. U.D.C. Twelve months' supply of electrical goods. Specifications from the Town Hall, Ball's Bridge, Co. Dublin.

Spain.—Tenders have just been invited by the municipal authorities of Narros del Castillo (Province of Avila) for the concession for the electric lighting of the town.

Swansea.—February 7th. Electric light installation, Brynmill School, for the Borough Education Committee. Mr. A. W. Holden, Clerk, 9, Grove Place (returnable deposit of £1 1s.).

Specifications for the items marked * can be seen at the Board of Trade Commercial Intelligence Branch in London.

CLOSED.

Auckland.—The U.D.C. has accepted the tender of Messrs. D. Latham & Co. for the E.L. installation at the new engine house at the waterworks, at £36.

Barnsley.—The Electricity and Lighting Committee has accepted the following tenders:—

Willans & Robinson.—Turbine, £2,590; condenser, £?,150.
Dick, Kerr & Co.—Alternator, £1,980.
B.I. & Helsby Cables, Ltd.—H.T. and L.T. feeders, £2,241.

Bath.—The D.C. has placed a contract with Messrs. Chamberlain & Hookham, Ltd., for meters for the ensuing year.

Cape Town.—The tender of the South African General Electric Co. has been accepted by the Corporation for a British Thomson-Houston turbo-alternator, for £12,160; also the tender of Messrs. Sykes & Co., at £3,050, for a rotary converter.

Dewsbury.—The Electricity and Tramways Committee of the T.C. has accepted the tender of Messrs. Heenan & Froude for an air filter, at £187.

Glasgow.—The T.C. Tramways Committee has accepted the following offers for scrap:—Copper, and armature coils, Messrs. P. & W. MacLellan; brass, and rubber-insulated cable, Messrs. R. M. Easdale & Co.; dry cells, Messrs. J. Jackson & Co.

Government Contracts.—List of new contracts for December, 1915:—

WAR OFFICE.

Electric cable and wire.—B.I. & Helsby Cables, Ltd.; Hooper's Telegraph and I.R. Works, Ltd.; Johnson & Phillips, Ltd.; Liverpool Electric Cable Co., Ltd.; Midland Electric Wire Co., Ltd.; Siemens Bros. and Co., Ltd.; Western Electric Co., Ltd.
Electric cells.—Siemens Bros. & Co., Ltd.
Electric lighting sets.—Fyfe, Wilson & Co.; Parsons Motor Co., Ltd.
Distribution boards, switches and fuses.—Kartrex Engineering Co.
Engines and generators.—Austin Motor Co. (1914), Ltd.; Keighley Gas and Oil Engines, Ltd.
Switchgear for transformers.—British Thomson-Houston Co., Ltd.
Generating sets and parts.—Austin Motor Co. (1914), Ltd.
Works services.—Electric lighting at R.F.C. Camp, Thetford: Mann, Egerton & Co. Electric lighting new hut hospital, Dublin: Ellis and Ward, Ltd. Electric lighting installation at Houghton Regis Camp: Grindlestone & Co. Electric lighting at hutted camps, Duddington and Dreghorn, Eastfield and Westfield.—Grindlay, Ross & Co., Ltd.
Power houses at Crombie and Rosyth.—W. Finlayson & Sons.

POST OFFICE.

Additional automatic equipment at Leeds Automatic Exchange.—Automatic Telephone Manufacturing Co., Ltd.
Insulators.—J. Bourne & Son; Taylor, Tunnicliff & Co.
Condenser paper.—Brittains, Ltd.
Battery zinc.—Eyre Smelting Co., Ltd.
Galvanised-iron wire.—R. Johnson & Nephew, Ltd.

H.M. OFFICE OF WORKS.

Engineering services.—Admiralty electric wiring: W. O. Rooper & Co.

London.—The London General Omnibus Co. has, we hear, just placed a large repeat order for electric lighting sets with Messrs. C. A. Vandervell & Co., Ltd.

Messrs. Pope's Electric Lamp Co., Ltd., have secured a renewal of their contract for carbon and metal-filament lamp requirements for 1916 from the Nelson Line of steamers. Owing to the large demand for Pope electric lamp shades, a further stock is being printed, and applications for them should be sent immediately.

HAMMERSMITH.—In order to augment the stock of coal at the electricity generating station, the Electricity Committee recommends the acceptance of the offer of Messrs. Cory Bros., Ltd., for a supply of 90 tons per week, to June 30th next, of ¾-in. Hucknall High Hazel coal, alongside Chancellor's Wharf, at 21s. 6d. per ton.

BERMONDSEY.—The following tenders have been received by the Borough Council for the supply of motors for the crusher plant:—

Supply and erection complete:	Motor revs.	Price.	Price without spare armatures.
J. Evans & Co.	950	£689	£512
General Electric Co., Ltd.	900	551	491
Cost of fitting spare armatures not included:			
Crompton & Co., Ltd.	1,000	541	491*
No erection, and spare armatures not fitted:			
Brit. Westinghouse Co., Ltd. ..	1,000	580	525
Brit. Thomson-Houston Co., Ltd.	1,020	551	503
Siemens Bros. & Co., Ltd.	1,000	545	494
Alternative tenders:			
J. Evans & Co.	950 / 1,100	786	709†
General Electric Co., Ltd.	900	615	727‡

* Plus 15s. per yard run of cable. † Enclosed pipe-ventilated motors. ‡ Totally-enclosed motors.

The Council is recommended to accept the tender of the General Electric Co., Ltd., at £551, plus 15s. per yard run of cable, estimated at £33. In its report on the subject the Finance Committee stated that it was informed that when the General Purposes Committee decided to recommend the Council to accept the tender of the General Electric Co. it did so upon its being reported to it that it would be the lowest tender, as it was thought that Messrs. Crompton & Co.'s tender did not include the cost of changing the spare armatures. It has since been ascertained that Messrs. Crompton's estimate did include such cost, as provided for in the specification. The Committee therefore, to save time, recommended the acceptance of Messrs. Crompton's tender.

The Electricity Committee has accepted the tender of the B.I. and Helsby Cables, Ltd., for three '5 units, complete with bus-bar, for mounting in Callender pillar, and one '3 unit, for £29.

Stretford.—The U.D.C. has accepted the tender of Messrs. W. T. Glover & Co., Ltd., at £356, for the supply of 400 yards of paper-insulated, lead-covered cable; also the tender of Messrs. Veritys, Ltd., at £53, for a 10-H.P. motor.

Swindon.—The T.C. has accepted the tender of the Acetylene Illuminating Co., Ltd., for an acetylene gas plant for use in connection with the repair of the tramway track, at £41.

Taunton.—Messrs. Chamberlain & Hookham, Ltd., have received a contract from the Council for meters for the year.

Windsor.—The T.C. has accepted the tender of the Pulsometer Pump Co., Ltd., for an electrical pump, at about £300.

FORTHCOMING EVENTS.

Royal Institution of Great Britain.—Friday, January 21st. At 5.30 p.m. At Albemarle Street. Lecture on "Problems in Capillarity," by Prof. Sir J. Dewar, F.R.S.
Thursday, January 27th. At 9 p.m. At Albemarle Street, W. Paper on "Fuel Economy from a National Standpoint," by Prof. W. A. Bone, F.R.S.

Greenock Electrical Society.—Friday, January 21st. At 7.45 p.m. At the Temperance Institute, 19, West Stewart Street. Paper on "Direct-current Machines," by Mr. J. A. Kinnaird.

Institute of Mechanical Engineers.—Friday, January 21st. At 8 p.m. At Great George Street, S.W. General meeting.

Association of Mining Electrical Engineers (West of Scotland Branch).—Saturday, January 22nd. At 4.30 p.m. At the Royal Technical College, Glasgow. Paper on "Electrical Shaft Winding," by Prof. D. Burns.
(**Notts and Derbyshire Branch**).—Saturday, January 29th. At University College, Nottingham. Paper on "Unusual Breakd wns in Colliery Electrical Plant," by Mr. R. Devine.

Manchester Association of Engineers.—Saturday, January 22nd. At the Grand Hotel, Aytoun Street. Paper on "Cast Iron: The Strength and Properties of Castings," by Mr. E. L. Rhead.

Salford Technical and Engineering Association.—Saturday, January 22nd. At 7 p.m. At the Royal Technical Institute. Presidential Address. Musical social evening.

Post Office Telephone and Telegraph Society of London.—Monday, January 24th. At 6.30 p.m. At the I.E.E., Victoria Embankment, W.C. Paper on "Public Administration and Finance," by Mr. F. C. Cook.

Institution of Civil Engineers.—Tuesday, January 25th. At 5.30 p.m. At Great George Street, S.W. Discussion on Mr. F. W. Carter's paper on "The Electric Locomotive."

Institution of Electrical Engineers (Manchester Local Section).—Tuesday, January 25th. At 7.30 p.m. At the Engineers' Club, 17, Albert Square. Paper on "The Principles of Modern Printing Telegraphy," by Mr. H. H. Harrison.

Liverpool Engineering Society.—Wednesday, January 26th. At the Royal Institution, Colquitt Street. Paper on "Recent Developments in Telephony," by Mr. G. C. Marris.

University College, London.—Wednesday, January 26th. At 5.30 p.m. At University College, Gower Street, W.C. First lecture on "The Electrical Production of Nitrates for Fertilisers and Explosives," by Mr. E. Kilburn Scott.

Leeds Association of Engineers.—Thursday, January 27th. At 7.30 p.m. At 5, Park Lane. Paper on "Electric Heating: Its Present Position and Future Development," by Mr. G. Wilkinson.

North-East Coast Institution of Engineers and Shipbuilders.—Friday, January 28th. At 7.30 p.m. At Bolbec Hall, Newcastle-on-Tyne. Ordinary general meeting.

NOTES.

The B.T.H. Co., Ltd.—With reference to an article that appeared in the *Sunday Chronicle* on "Germans and the Electrical Industry," a couple of months ago, in which the writer, one "John Briton," made certain references to the British Thomson-Houston Co., Ltd., a further article appeared in the same paper on Sunday last, in which the writer says:—

"When I wrote last on the German influence in the electrical industry, some two months ago, I gave an account of the extraordinary ramifications of the great German Trust, called briefly the A.E.G., of Berlin, and in this connection, before I go further, I desire to clear up an unfortunate misunderstanding. Among the 'Allied and subordinate' companies, of which I gave a list, I mentioned the British Thomson-Houston Co., of Rugby. I did not say that this company was owned or controlled by the A.E.G., but this inference has been drawn from my article, and I therefore desire to say that it is unfounded.

"The truth is that the B.T.H., of Rugby, is mainly controlled by the General Electric Co., of Schenectady, which in its turn is a descendant of the Thomson-Houston Co., of America. The Thomson-Houston Co. in its day sold its European patents to a number of companies on this side of the Atlantic, some of which in due course were absorbed by the A.E.G. and some by the G.E. Co.

"The British Thomson-Houston Co. belongs, as I have said, to the latter category. It is true that the A.E.G. purchased the German rights under the patents of the G.E. Co. and the B.T.H. Co. in exchange for the American and British rights under its patents, but I am glad to be able to state that the German company has no control over, or interest in, either the American or British company, and I regret if any other meaning has been read into my article, and if any harm has been done to the B.T.H. Co. thereby. I am also able to state that the A.E.G. has no control over the electric lamp business in this country, but on the contrary, by reason of British patents it was obliged to purchase from British companies all such lamps as it sold here."

Trading with the Enemy.—The New Bill.—As we go to press the text of this Amendment Bill is being published. Among other things it gives the Government power to wind up enemy businesses under certain circumstances. We shall refer to the matter next week.

Inquiries.—Makers of appliances for the manufacture of storage batteries are asked for.

Appointments Vacant.—Electricians and motor mechanics are wanted for military camp power-houses (South of Ireland district), at 40s. to 45s. +.

The Development of Italian Hydro-Electric Works.—The conference to which we briefly referred in our last issue took place in Milan, in the offices of the Società Imprese Elettriche, in the presence of Senator Facheris and a number of members of the Lower Chamber, and from a report of the proceedings now to hand, it would appear that the responsibility for assisting Italy to develop the water powers of the country for industrial purposes in general rests with the Government. Signor Ettore Conti, the engineer who had been invited to give an address on the subject, first referred to the great importance attached at the present time to the question of the electrical industry in relation to national independence and the economic defence of the nation. In view of the European conflict, he stated that the Italian industry must fight on the side of the army, and in order to attain the object which had been predetermined in the Italian war it was also necessary to strive in the economic field, so as to secure that industrial independence which had been endangered by the hegemonical dream of the Central Empires, in the sense of endeavouring to translate it into reality first by trying to surpass from an economic point of view, and then by supporting this by force of arms. The independence of Italy would be achieved, in his opinion, by the adoption of a right policy with regard to Customs and transport services, the diffusion of professional education, the regulation of credit, and above all by the pursuit of an enlightened national policy in respect of the utilisation of water powers. Dealing then with the problem from various standpoints, the lecturer first discussed the subject of the conversion of the railways to electric traction. It would be impracticable to transform the whole of the railway mileage so as to work it by means of power obtained from hydroelectric works, as such a scheme alone would require 1,000,000 H.P. But it would be possible to increase the present electrically-operated mileage of 210 to 1,200 miles within a period of 10 years, and at an expenditure of £4,000,000. It would also be practicable for a considerable portion of the power required by the industries of the country to be obtained from electricity instead of coal, and electricity could also be employed as motive power in agricultural operations and for the extraction of nitrogen from the atmosphere for fertilising purposes.

The question of the sale price of electricity next engaged attention. On this point Signor Conti stated that the price per KW.-hour was 9·6d. 30 years ago. It was now sold to large industrial consumers at from ½d. to ⅝d., and at $\frac{1}{10}$d. per KW.-hour in special cases. He was firmly convinced that it would be possible to establish hydroelectric works which would be able to dispose of energy at from $\frac{1}{10}$d. to ½d. per KW.-hour, and when that object was achieved the iron and steel and chemical industries in Italy would no longer be exceptional industries. After having reviewed the existing legislation with regard to the electrical industry, the speaker submitted that nothing had been done in this way to encourage the national industry. If the electrical industry was to be developed on a grand scale, so as to render possible the erection of large stations and consequently the supply of energy at cheap rates, the Government would have to avoid delays and solve the problem fully, bearing in mind the legitimate and modest wishes of industrialists, whilst at the same time the State revenue would rapidly increase to the advantage of the country. The lecturer met with a very cordial reception, and the discussion which ensued largely turned upon the means to be adopted in approaching the Government with a view to the adoption of immediate measures so as to permit existing hydroelectric works to be enlarged without delay by the construction, in the first place, of new reservoirs with the object of coping with the scarcity of coal.

The members of the Lower Chamber present expressed themselves convinced of the urgency of the problem, and a Committee was appointed to draw up a petition to be presented personally to the Government. In the meantime the address is to be printed in pamphlet form, and copies will be sent to all the deputies in order to secure their support in favour of this movement. A considerable time will be required before any practical advantage can be derived from the granting of facilities by the Government in the near future. That the Government will assist the electrical industry, as well as other industries, to secure independence from the Teutonic yoke seems very probable.

Fatalities.—METHIL.—At Kirkcaldy, Fife, on Friday, Sheriff Armour Hannay and a jury conducted an inquiry into the circumstances of the death of Alex. Martin, apprentice electrician, residing at Methil, who died on December 11th, 1915, in the No. 2 Pit, Leven Collieries, owned by the Fife Coal Co., from an electric shock.

George Meredith, foreman electrician, said the boy Martin, who was 15½ years of age, had been with him for about a year. On the day in question he had instructed the lad to replace a lamp on the west side of the pit bottom. All apprentices were warned not to touch high-tension panels. Witness stated that he did not think it possible to apply to that particular panel the locking apparatus suggested by the Inspector of Mines. The door of the panel had been levered open by the deceased, who was a lad keen on his work, and was undoubtedly curious. Joseph Laurie, the motorman, said deceased came to his room and said: "Here are two lamps for you." Witness then heard Martin open the door of the panel, and shouted: "Watch what you're doing now." Deceased replied: "It's all right, I have the gloves on." Witness then said: "See and mind." Witness received no answer, and on looking over to see what deceased was doing he saw Martin standing with his back against the panel and his mouth open. Witness took off the switch, and the lad fell back in his arms and never recovered. There was a mark on his forearm like a burn. George Gordon Fraser, chief electrical engineer to the company, said the panel was quite safe. There were sufficient notices of danger. The lad knew and had been warned of the danger. No matter what locking device was used, there would be danger in the human element. The Sheriff suggested that the jury add a rider to their formal verdict recommending that more stringent precautions and regulations be adopted in regard to apprentice electricians, and that the mines inspector should be invited to consider, along with the management, what electric device for protecting such panels could be adopted. Mr. Macgregor, the coal company's representative, addressing the jury, pointed out that no matter what device was adopted, so long as boys were boys and did not obey their superiors, accidents were bound to arise. A formal verdict was returned, the jury adding a rider as recommended by his Lordship.

A motor-car collided with an electric standard on the Victoria Embankment, London, on 17th inst. The standard was broken off 12 ft. from the ground, and one man was killed.

Volunteer Notes.—ENGINEERING INSTITUTIONS' VOLUNTEER ENGINEER CORPS.—Orders for week commencing January 24th, 1916.—By Lieut.-Col. C. B. Clay, V.D., Commandant.

Drills, 6.25 to 7.25; 7.25 to 8.25 p.m.

Monday, January 24th.—Sections 1 and 2, Technical; Sections 3 and 4, Lashings and Trestle Bridging, Signalling Class and Recruits.

Tuesday, January 25th.—School of Arms, 6 to 7 p.m.

Thursday, January 27th.—Shooting for Sections 1 and 2, and Signalling Class.

Friday, January 28th.—Sections 3 and 4, Technical; Sections 1 and 2, Lashings and Trestle Bridging; Signalling Class and Recruits.

Saturday, January 29th.—Uniform Parade, 2.45 p.m.

Sections for Technical Parade at Headquarters, London Electrical Engineers, 46, Regency Street, S.W.

Sections for Shooting Parade at Miniature Ranges.

Unless otherwise ordered, all Parades at Chester House.

E. G. FLEMING,
Company Commander and Acting Adjutant.

3RD BATT. (OLD BOYS) CENTRAL LONDON REGIMENT (VOLUNTEERS).—Battalion Orders by Colonel S. G. Grant (Officer Commanding), Thursday, January 20th, 1916:—

Week-end Parades.—The Inter-Platoon Competition will be fired at the Acton Range on Saturday next, the 22nd and 23rd inst. This will take the place of the usual week-end parades.

"*Derby*" *Recruits* will parade at Wembley Park, on Saturday and Sunday next, at the usual times.

Musketry.—The Acton Range will be open on Saturday morning, the 22nd inst., for Inter-Platoon Competition practice. Members to parade at 11 a.m. Names to be sent to Musketry Staff not later than Friday mid-day.

The Competition will commence on Saturday afternoon, the 22nd inst., at 1 p.m. The competing Teams are Platoons Nos. 2 and 3, Blackheath and North London.

The Competition will be continued on Sunday, the 23rd inst. The Teams—Platoons Nos. 5, 10, 13 and 14—are to Parade at 11 a.m. Teams—Platoons Nos. 4, 7, 12 and 15—to Parade at 2 p.m.

Men to Parade punctually, in uniform, with bayonets.

Non-competitors may attend to witness Competition.

A. G. JOINER, *Major and Adjutant*, O.B.C.

Institution and Lecture Notes.—The Institution of Electrical Engineers.—We are informed by the secretary of the Institution, Mr. P. F. Rowell, that the Council has passed the following resolution:—

"The Council are of opinion that Clause 41 of the Articles of Association provides sufficient means for the expulsion of undesirable persons (whether alien enemies or not) from the Institution, consistently with making the thorough investigation of the circumstances of each case which is essential in order to avoid the risk of doing grave injustice to individuals."

The Council has also under consideration the question whether the Institution should obtain further powers for the expulsion of alien enemies.

[We pointed out on December 31st that Article 41 contained adequate powers for the expulsion of alien enemy members, and in our last issue we surmised that the Council would not take action in the matter, having already returned an evasive reply to inquiries on the subject. Whether anything will be done depends entirely upon the members of the Institution, as Article 41 can only be brought into operation by the action of individuals, and the Council, it will be observed, is not committed to any policy whatever.—EDS. ELEC. REV.]

Metropolitan Association of Electric Tramways Managers.—A meeting of the members of this Association was held on 14th inst., at the Municipal and County Club, Whitehall, when the following were present:—Messrs. Ullmann (East Ham), chairman, Schofield (Leyton), vice-chairman, Moffet (West Ham), Harvey (Ilford), Mackinnon (London United), and Goodyer (Croydon), hon. secretary. Letters were received from Messrs. Fell (L.C.C.), Bruce (L.C.C.), Murray (Walthamstow), Stokes (Bexley), Hammond (Metropolitan Electric), Williams (Erith), and Mason (South Metropolitan), who were unable to attend. Various matters of interest were discussed.

Chinese Power House Bombed.—A Central News dispatch from Hong-Kong, states that on January 14th while the chief engineer of the Kwang-Tung Electric Supply Co. was entertaining some friends, including the British Consul, at a bridge party, an unknown miscreant threw a bomb into the company's power house. All the windows were smashed, and two or three coolies were killed.

Lead Poisoning in Accumulator Works.—During the month of December, 1915, twelve cases of lead poisoning in electrical accumulator works were reported to the Home Office under the Factory and Workshop Act, the total cases for the year being 64 as against 41 for 1914.

The Prussian Government and Electricity Works.—The Spanish newspapers have recently recorded complaints made in some political circles alleging that certain new laws have become dead letters—dead in the sense that they have never been promulgated since they were passed, and have, as it would seem, almost become forgotten. But a still stranger case has just been brought to light in Germany, where a joint decree, made on May 26th, 1914, was published for the first time in the middle of January of the current year. The decree, which is signed by the Prussian Minister for Trade and Industry, the Minister for Public Works, and the Minister for Internal Affairs, relates to the supply of electricity, but it is not connected with the scheme reported to be in prospect for the nationalisation of the supply industry. The object of the decree is to secure a greater measure of production for the public interests in regard to overland central stations, the establishment of which has not required the sanction of Parliament—but which has been merely subject to private agreements and the consent of officials representing the Government authorities. In future, however, certain restrictions are to be imposed, and the promoters of overland stations are only to obtain the right of expropriation, the use of Government ground property (waterways of first importance, domains, forests and railways), after the Government officials for the districts concerned have settled the requirements to be stipulated in the general public interest.

The decree points out, in the first place, that the requirements cannot be prescribed from a general standpoint, as the requisite experience is lacking, particularly as the conditions coming into consideration are so varied that it is impossible to deal with all cases in a uniform manner. Hitherto the right of expropriation has been made dependent upon the non-existence of a monopoly in the delivery of materials and plant for installations. In appropriate instances the undertakers have been placed under the obligation to furnish energy to everyone in their area of supply in so far as this could be effected without endangering the economy of the undertaking, and this condition will also be adhered to in the future. Efforts must be directed, the Government officials are instructed to secure that the supply of districts yet unprovided with electricity shall not be undertaken arbitrarily by one or another undertaker, but that it shall be proceeded with in the most economical manner. The appropriate supply of a district may be prejudiced for a long time by the erection of small works of limited capacity, whilst at the same time large and efficient works, if they supply only the more profitable parts of a great area, would also prejudice the equal treatment of favourable and unfavourable districts that is requisite for the systematic supply of the whole of the area. This can also take place in the case of municipal works extending their supply to parts of the outlying districts, for which a different supply under circumstances would be more suitable for the whole.

It is now proposed, as occasion may arise, to bring the influence of the State to bear in this direction in the case of existing works by only permitting them to make use of State lands according as the opportunity offers, when they give legal undertaking to the Government officials for the district not to exceed, without the consent of the latter, the line of demarcation representing the whole of their present area of supply. In the case of those works which possess the right of expropriation for a specified area without this undertaking being imposed, this measure will also apply in order to prevent them from supplying beyond their particular areas without the sanction of the Government officials. The proposed establishment of new works will be subject to inquiry as to whether their erection should be opposed or as to how the line of demarcation for them shall be drawn. Both in the case of existing works and of new stations the conditions can be imposed that neighbouring districts shall also be supplied even if they promise to yield a lower return. A further important object is to prevent the existing tendency for the development of private supply monopolies from further growing, which has also to be taken into consideration in fixing the line of demarcation, whilst efforts must be made to obtain a right of determining whether works which have been established by local authorities or with the substantial participation of such authorities, shall in future come under the control of private undertakings. The decree, which is apparently addressed to the Government officials in each district, further suggests the possibility of influencing the fixing of charges for supply in so far that the charges must be re-examined at certain intervals, and a reduction demanded as occasion may arise. These instructions are neither regarded as exhaustive nor are they to be considered without distinction in every case, the duty of the State, the decree concludes, being to keep the development on sound lines, but not to hamper it.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry also electric tramway and railway officials, to keep readers of the ELECTRICAL REVIEW *posted as to their movements.*

Central Station and Tramway Officials.—Mr. J. DUGDALE, the Oldham Corporation tramways manager, has strained the ligaments of one of his legs while on a visit to Rotherham, and is laid up there.

Mr. D. LLOYD has resigned his position as engineer to the Abertillery U.D.C., he having received an appointment under Messrs. Partridge, Jones & Co.

Messrs. YOUNG and YELDHAM, of the Swansea Corporation electricity staff, have joined the Forces.

The Barnes U.D.C. has granted Mr. G. C. LAW, assistant electrical engineer at the electricity works, a gratuity of £50 for additional services rendered since the outbreak of the war to December 31st last.

Mr. WALTER F. LONG, the city electrical engineer at Cape Town (a position which he has occupied for nearly 14 years), has resigned in order to take up an appointment as general manager of the Cape Town Tramways Co. Mr. S. J. CLUNAS, who has been station engineer for some years, and has acted as deputy for Mr. Long during his absence, has been appointed acting city electrical engineer.

General.—Mr. R. G. BLAKE, a young electrical engineer, employed by Messrs. Deveraux & Moody, Newcastle, has been presented, on behalf of the Carnegie Hero Trust Fund, with a silver watch, and on behalf of the Royal Humane Society with a certificate on vellum, for having rescued a boy who was drowning in the Tyne.

Mr. D. H. MORRIS, Glasgow manager of Messrs. Lowdon Bros. & Co., has been given a commission in the R.N.V.R.

Mr. J. T. TAYLOR, late representative for Messrs. Pirelli, Ltd., has now joined the staff of the British Thomson-Houston Co., Ltd.

Second-Lieutenant A. R. COURTENAY (late acting-manager of the publication department, General Electric Co., Ltd.) has sailed for the Mediterranean. After about two months' active service in France with the R.N.A.S., Armoured Car Aeroplane Support (R.N.V.R.), he transferred to the Army Service Corps, and he is now a Second-Lieutenant in this Corps.

The Herbert Frood Co., Ltd., of Chapel-en-le-Frith, ask us to state that Mr. W. E. DIXON is not now in their service.

Mr. HAROLD BOUCHER, who has been acting as electrical engineer on one of H.M. Hospital Ships, has just returned from the Dardanelles, and been appointed electrical engineer to the Norman Flight Co., Bognor.

The *London Gazette* contains the following notice:—Territorial Force. London Electrical Engineers. The undermentioned to be Second-Lieutenants:—Sapper G. S. H. Cox; Private A. D. Hedgcock, from the H.A.C.; and Lance-Corporal G. A. Wadham, from Royal Fusiliers.

Mr. A. P. KELSEY, one of Messrs. Falk, Stadelmann & Co.'s country representatives, has joined the Royal Flying Corps.

Roll of Honour.—Private ARTHUR BOOTH, of the Ashton Territorials, who has been wounded in action, was an electrician employed by Messrs. Armstrong, Whitworth and Co., Manchester.

Private WM. ROYLE JENKINSON, of the 13th Cheshire Regiment (Wirral "Pals"), who has fallen in action in France, was, until his enlistment after the outbreak of war, engaged as an electrical engineer with Messrs. Lever Bros., Ltd., Port Sunlight.

Private ALBERT W. CAPELL, of the Rifle Brigade, who was, prior to his enlistment, on the staff of the British Thomson-Houston Co., Ltd., at Rugby, has been killed in action in France. He returned to the Front two days before Christmas after recovery from fever.

The death is reported, in action in France, of Private FRANK JONES, of the 1st Buffs (East Kent Regiment), formerly on the staff of the Isle of Thanet Tramways Co.

Mr. KENNETH GEIPEL, of Messrs. Wm. Geipel & Co., who has been serving in the Royal Engineers at the front in France, has been wounded, and is in hospital in this country.

Obituary.—MR. GEORGE TUCKER.—We regret to record the death, which occurred on Saturday last, at his residence in Lordship Road, Stoke Newington, of Mr. George N. G. Tucker, of the *Electrician* Printing & Publishing Co., Ltd. Mr. Tucker, who was in his 64th year, was associated with the *Electrician* in one capacity or another from 1878, the year in which the present paper first made its appearance, down to the time of his death. He became principal proprietor of the paper about ten years ago. Between the years 1878 and 1888 his interests naturally centred chiefly around submarine and land telegraphy. Mr. Tucker was responsible for the publication of "The Electrician" series of technical books, in which the researches and studies of many brilliant writers are contained, among such authorities being Heaviside, Ewing, Gore, Carter, Lodge, and Mrs. Ayrton. Mr. Tucker also founded the *Electrician* Electrical Trades Directory and Handbook (the Blue Book), and he took a personal interest in its production. He seldom missed the Electro-Harmonic concerts, even in recent years, and only failing health prevented his attendance up to the last.

CAPTAIN COLTHURST VESEY.—The directors of the Dublin and Lucan Electric Railway have placed on record their deep regret at the death of Captain Colthurst Vesey, D.L., vice-chairman, who had been associated with the concern for 18 years. Captain Vesey was also a director of the Dublin United (Electric) Tramways Co.

MR. W. C. BLENKARNE.—We regret to record the death of Mr. W. C. Blenkarne, senior London traveller for Messrs. Falk, Stadelmann & Co., Ltd., who was well known in the lighting trade throughout London, more particularly in the Southern districts, where of late years he had represented the above firm. The deceased gentleman was for a long time interested in a London glass works, but he abandoned this on joining the staff of Falk, Stadelmann & Co., Ltd., in 1891, whom he represented until his death on the 12th inst. He had seen longer service with the firm than any other London traveller.

MR. R. C. FREWER.—The death has taken place, after an operation, of Mr. Robert Chas. Frewer, who had been on the staff of Siemens Bros. Dynamo Works Co., of Stafford, for 25 years. He was 48 years of age.

Wills.—The late Professor VIVIAN B. LEWES left £13,353.

SIR A. W. RUCKER'S estate amounted to £40,465.

NEW COMPANIES REGISTERED.

South Wales and West of England Wireless Training College, Ltd. (142,641).—This company was registered on January 6th, with a capital of £5,000 in £1 shares, to carry on a college or school for training and instruction in wireless telegraphy and telephony, and electrical and other engineering, and to adopt agreements (1) with the South Wales Wireless Training College, Ltd., and (2) with J. R. Schofield. The subscribers (with one share each) are: W. N. Jones, Dyffryn, Ammanford, colliery proprietor; D. Radcliffe, Pen-y-lan, Cardiff, shipowner. Private company. The number of directors is not to be less than two or more than seven; the subscribers are to appoint the first. Qualification, £250. Registered office: Market Buildings, St. Mary Street, Cardiff.

Parsons and Hodges, Ltd. (142,731).—This company was registered on January 15th, with a capital of £3,000 in £1 shares, to take over (1) the business of an electrical, mechanical and general engineer and contractor carried on by A. J. Hodges, at Regent Street, Leamington, in succession to W. Parsons & Co., Ltd., and (2) the similar business carried on by A. E. Mason, at 63, Parade, Leamington, as Receiver for the debenture-holders of Brown & Parsons (1913), Ltd. The subscribers (with one share each) are: W. Parsons, 63, Parade, Leamington Spa, electrical engineer; A. J. Hodges, 26, Strathearn Road, Leamington Spa, electrical engineer. Private company. The number of directors is not to be less than two or more than five; the subscribers are to appoint the first. Solicitor: G. Williams, Bank Buildings, Cradley Heath. Registered office: 63, The Parade, Leamington, Warwick.

Atkinson, Lloyd and Co., Ltd. (142,724).—This company was registered on January 15th, with a capital of £500 in £1 shares, to carry on the business of electrical engineers, manufacturers, agents, and contractors. The subscribers (with one share each) are: J. E. Atkinson, 120, Moss Lane, Swinton, Manchester, electrical engineer; S. Lloyd, 28, Duchy Street, Seedley, Manchester, electrical engineer; R. F. Peacock, 26, Scarisbrick Road, Levenshulme, Manchester, electrical engineer. Private company. The number of directors is not to be more than three; the first are J. E. Atkinson, S. Lloyd, and R. F. Peacock. Solicitor: W. I. Hawken, 71, Market Street, Manchester.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Burt, Escare and Denelle, Ltd.—Particulars of £7,500 debentures, created December 22nd, 1915, filed pursuant to Section 93 (3) of the Companies (Consolidation) Act, 1908, the whole amount being now issued. Property charged: The company's property, present and future, including uncalled capital (if any). No trustees.

A memorandum of satisfaction in full on December 30th, 1915, of debenture stock dated April 14th, 1911, securing £3,900, has been filed.

Coatbridge and Airdrie Electric Supply Co., Ltd.—Further charge on the Coatbridge and Airdrie undertakings and the company's undertaking and property, present and future, including uncalled capital, and benefit of certain agreements, contracts, etc., dated December 30th, 1915 (supplemental to charge dated October 17th, 1906), to secure £4,600. Holders: County of London Electric Supply Co., Ltd., Moorgate Court, Moorgate Place, E.C.

David Anderson and Co., Ltd.—Particulars of £5,500 debentures, created July 21st, 1915, filed pursuant to Section 93 (3) of the Companies (Consolidation) Act, 1908, the amount of the present issue being £100. Property charged: The company's undertaking and property, present and future, including uncalled capital. No trustees.

Issue on December 17th, 1915, of £3,200 debentures, part of a series of which particulars have already been filed.

Ellis and Ward, Ltd. (107,215).—Capital, £10,000 in £1 shares. Return dated September 28th, 1915. 6,703 shares taken up; £703 paid; £6,000 considered as paid. Mortgages and charges: Nil.

Credenda Conduits Co., Ltd. (126,340).—Capital, £50,000 in £1 shares. Return dated July 7th (filed November 18th), 1915. All shares taken up; £30,000 paid; £20,000 considered as paid. Mortgages and charges: Nil.

Hong-Kong Tramway Co., Ltd.—A memorandum of satisfaction to the extent of £300 on October 26th, 1914, of trust deed dated July 1st, 1903, securing £105,000, has been filed.

Electric Reduction Co., Ltd. (54,724).—Capital, £50,000 in £1 shares (16,200 pref. and 33,800 ord.). Return dated December 7th, 1915. 16,200 pref. and 28,800 ord. shares taken up; £1 per share called up on 13,000 pref. and 5,000 ord.; £18,000 paid; £27,000 considered as paid on 3,200 pref. and 23,800 ord. shares. Mortgages and charges: £25,000.

M. & G. Truck and Engineering Co., Ltd.—Particulars of £1,500 debentures, created January 5th, 1916, filed pursuant to Section 93 (3) of the Companies (Consolidation) Act, 1908, the amount of the present issue being £1,400. Property charged: The company's undertaking and property, present and future, including uncalled capital. No trustees.

Resisto-Electrical Manufacturing Co., Ltd.—Issue, on October 11th, 1915, of £900 debentures, part of a series of which particulars have already been filed.

Monte Video Telephone Co., Ltd. (27,208).—Capital, £160,000 in £1 shares (87,000 pref.). Return dated November 10th, 1915. 86,492 pref. and 72,680 ord. shares taken up; £159,172 considered as paid. Mortgages and charges: Nil.

Newtons, Ltd. (48,936).—Capital, £40,000 in £10 shares. Return dated October 5th, 1915. 3,265 shares taken up; £18,650 paid; £14,000 considered as paid. Mortgages and charges: £14,000.

Pirelli, Ltd. (103,068).—Capital, £8,000 in £5 shares. Return dated September 13th, 1915. £8,000 paid. Mortgages and charges: Nil.

Cape Electric Tramways, Ltd. (54,636).—Capital, £500,000 in £1 shares. Return dated November 24th, 1915. 491,222 shares taken up; £91,222 paid; £400,000 considered as paid. Mortgages and charges: £391,300.

Frederick Braby and Co., Ltd.—Capital, £400,000 in £10 shares (2,500 pref.). Return dated September 2nd, 1915. 27,500 ord. and 2,500 pref. shares taken up; £10 per share called up on 24,250 ord., £6 per share on 3,250 ord. and £10 per share on 2,500 pref.; £287,020 paid (including £20 paid on 5 shares forfeited); £13,000 considered as paid, being £4 per share on 3,250 shares. Mortgages and charges: £55,000.

General Accessories Co., Ltd. (104,464).—Capital, £3,000 in £1 shares (1,580 six per cent. pref., 920 five per cent. pref., and 500 ord.). Return dated August 10th (filed December 10th), 1915. All shares taken up; £1,580 paid; £1,420 considered as paid. Mortgages and charges: Nil.

Ruthin Electric Supply Co., Ltd. (138,021).—Capital, £5,000 in 400 pref. of £5 each and 1,000 pref. ord. and 2,000 ord. shares of £1 each. Return dated December 9th, 1915. 126 pref., 673 pref. ord., and 1,110 ord. shares taken up; £2,388 paid, leaving £25 in arrears. Mortgages and charges: Nil.

Railway Finance and Construction Co., Ltd. (72,015).—Capital, £100,000 in £1 shares. Return dated November 12th, 1915. 92,292 shares taken up; £1 per share called up on 657 and 4s. per share on 29,595 shares; £6,576 paid; £85,716 considered as paid, being £1 per share on 62,640 shares and 16s. per share on 29,595 shares. Mortgages and charges: Nil.

Electro Flex Steel Co., Ltd.—Issue on December 30th, 1915, of £4,000 debentures, part of a series of which particulars have already been filed.

Lamplough and Son, Ltd.—Memoranda of satisfaction in full on December 16th, 1915, of two debentures and a mortgage created by the receiver, and dated June 17th and January 4th, 1913, and May 14th, 1914, securing £500, £700, and £1,500 respectively, have been filed.

CITY NOTES.

French Electrical Companies.

The *Compagnie d'Electricité de l'Est Parisien* (*Est Lumière*), which has a share capital of £400,000, reports net profits and balance forward amounting to £55,000 for 1914-15, which has been transferred to the special reserve fund. No dividend was paid either in 1913-14, when the net profits of £39,000 were carried forward.

The *Compagnie Electrique de la Loire et du Centre*, which reports a large reduction in the gross profits in 1914-15, records net profits of £59,000, as contrasted with £95,000 in 1913-14, which sum was carried forward. These two amounts permit of the payment of a dividend of 6 per cent., and the appropriation of £90,000 for the general reserve fund for redemption.

The *Compagnie d'Electricité de l'Ouest Parisien* (*Ouest Lumière*) reports a great decline in the receipts in 1914-15, the profits being £65,000, as against £124,000 in 1913-14. Including the balance brought forward from the previous year, the net surplus available amounts to £107,000, which permits of the payment of a dividend of 6 per cent., as contrasted with no distribution in 1913-14.

The working results of the *Société d'Electricité de Paris* have been seriously affected through the war. According to the accounts for the year ended with June 30th, 1915, the gross profits amounted to £158,000, as compared with £275,000 in the previous year. By reducing the sum usually set aside for depreciation and renewals, the net profits have only declined from £105,000 in 1913-14 to £91,000 last year, the dividend being fixed at 16s. per share.

The report of the *Compagnie Générale d'Electricité, of Paris*, for the year ended with June 30th, 1915, states that the net profits amounted to £124,000, as compared with £148,000 in the previous year, when any distribution of profits was postponed. It is now proposed to pay a dividend at the rate of £1 per share for each year, to place £160,000 to a special reserve fund for current risks, and to carry forward the sum of £32,000. The allocation of this large sum to the reserve fund is explained by the statement that the company's liquid funds are scanty, whilst the great fluctuations in prices in the metal market may give rise to unexpected demands. The payment of the dividends is deferred for the present owing to the funds being provisionally tied up.

The *Société Industrielle des Téléphones, of Paris*, whose manufactures are in special request in connection with the work of national defence, reports that although the State is now the principal customer, private firms continued to place orders fairly regularly in 1914-15. Out of the six works, of which five are in the vicinity of Paris, only that at Calais suffered from the prevailing circumstances, as it had to be closed, and was occupied at present by the Belgian Army. The Calais works, which produces submarine cables, would have experienced the results of a lack of work even if events had not induced the directors to shut down. The net profits are returned at £69,000, as compared with £71,000 in 1913-14,

the reduction being due to the allocation of £14,000 to the needs of the workmen who have been mobilised. It is intended to pay a dividend of 12s. per share, as against 9s. 7d. per share in 1913-14, the former rate reaching the level of that prevailing prior to the war.

The *Société d'Applications Industrielles, of Paris*, which is an investment company in which are interested the Swiss Bank Verein and the Swiss Motor Co. for Applied Electricity, proposes to carry forward the net profits of £4,000 realised in 1914-15, as in 1913-14, when the net profits reached £32,000. In explanation of this intention, the directors state that two subsidiary undertakings—the Energie Electrique du Nord and the Est Electrique—are situated in the districts occupied by the enemy, and no accounts were therefore available. Many other companies with which the Trust is also financially concerned had either reduced or omitted the payment of dividends under the existing conditions in order to keep their resources liquid for any eventuality. In addition, the cost of producing electrical energy, particularly in the case of steam power stations, had greatly increased in consequence of the dearness of coal, whilst the receipts of individual companies, which in normal years rose by 15 per cent., had fallen by that percentage in the past year.

Transport Companies in Berlin.

It appears that the traffic receipts of the electric tramways and the elevated and underground railway in Berlin have recently so much improved that it is claimed that these two undertakings have now recovered from the unfavourable influence of the war. Although information is not available concerning the working expenses, figures which have been published in that city show that the gross receipts of the Berlin Grand Tramways Co. amounted to £2,102,000 in 1915, or £57,000 more than in 1914, but £121,000 less than in 1913. The gross receipts of the Berlin Elevated and Underground Railway Co. were £452,000, or £52,000 less than in 1914 and £16,000 less than in 1913. On the other hand, the Berlin General Omnibus Co., whose horses and motor 'buses were requisitioned very largely by the Army authorities, reports receipts of £362,000 in 1915, this total being less by £221,000 than in 1914, and less by £301,000 than in the previous year. Since last August the returns issued monthly by the tramway company have shown that the large decreases which commenced on the outbreak of the war have been regularly reduced. In fact, the receipts in August, September, October, and November reached the level of those which obtained in the corresponding months in the peace year of 1913. At the same time, the diminution in the receipts during the war, which attained the maximum of £33,000 in September, 1914, must not be ascribed exclusively to the war, as the tramway company's receipts began to decline slightly in September, 1913, on the opening to traffic of the Schonhauser section of the overhead and underground railway. The diversion of traffic by the latter, however, seems to have now ascended to its maximum position, and any further appropriation of traffic seems out of the question in the near future. In a similar way the electric railway company appears to have surmounted the difficulties created by the war. Although the company's receipts in the last months of 1915 were on the average 16 per cent. less than in the equivalent months in 1913, the receipts since September have regularly advanced as compared with the corresponding months in 1914, and the total decrease of £52,000 in 1915 as against 1914 is attributed exclusively to the working results in the first seven months of the year. The recovery of both undertakings, as will be understood from the great reduction in the traffic of the omnibus company, has been effected at the expense of the latter, although this is immaterial financially, as the tramway company and the railway company each hold one-third of the ordinary shares in the omnibus undertaking. It is, however, questionable whether the latter, even if its full complement of horses and motor 'buses had been available, would have endeavoured to cultivate traffic under the existing conditions incidental to the higher cost of maintenance due to the great cost of fodder and benzine on the one hand, and the low fares on the other, which would probably have resulted in insignificant profits after provision had been made for depreciation.

German Electrical Companies.

The *A.G. für Gas und Elektrizitats, of Cologne*, whose expectations as to a progressive improvement in the situation of the undertaking have been unfulfilled through the war, will be unable to pay any dividend for 1915, as was also the case in the previous year.

The *Elektro-Osmose, A.G., of Berlin and Frankfort*, reports that the development of the undertaking in 1914-15 was greatly hampered through the war, and the carrying out of a number of installations had, therefore, to be postponed. On the other hand, considerable progress was made in the technical scientific work. As a result of the year's operations a loss of £14,000 was incurred, thus increasing the debit balance to £44,000 on a share capital of £150,000.

The financial statement of the *Kontinental Telegraphen Compagnie, of Berlin*, for 1914-15, indicates a loss of £3,400 on the telegraph business, as compared with profits of £2,500 in the previous year, but the income from investments was £3,500, as against £3,600. Including the balance brought forward, the accounts show net profits of £250, as contrasted with £6,200, and no dividend is in contemplation, whereas a rate of 11¼ per cent. was paid for 1913-14.

The *A.G. für Stickstoffdunger, of Knapsack*, reports that operations were practically at a standstill in the first months of the war, and it was only towards the end of 1914 that it was possible gradually to bring the plant into full working with the exception of the ammonia factory. The large demand for nitrogen then rendered it possible fully to utilise the installations. As a result of the rupture of the contract on the part of the English, French, and Italian constituents, the Berlin Sales Bureau for Nitrogenous Fertilisers was dissolved, and the International Carbide Syndicate had also collapsed. The net profits realised by the Knapsack company in the year ended with June, 1915, amounted to £35,000, as contrasted with £25,000, and a dividend of 10 per cent. is recommended on the share capital of £150,000, which has now been increased to £400,000, as compared with 6 per cent. in 1913-14.

The directors of *Siemens Elektrische Betriebe, A.G., of Berlin*, reporting on the year ended September 30th, 1915, state that although the war exercised an unfavourable influence on the various supply works owned and leased by the company, the value of the total connections increased by over 10 per cent., and the receipts by about 7 per cent. In peace times, however, the augmentation would have been considerably greater than was represented by these percentages. On the other hand, the working expenses largely advanced owing to the dearness of coal and materials and higher wages. After appropriating £28,000 for depreciation, as compared with £24,000 in 1913-14, and placing £15,000 to the renewal fund, as against £13,000, the net profits are returned at £83,000, as contrasted with £75,000 in 1913-14. It is proposed to pay a dividend of 5 per cent., as compared with 6½ per cent. in the previous year, the participating ordinary share capital of £1,500,000 being greater than in 1913-14.

The *A.G. für Elektrizitats Anlagen, of Berlin*, which owns a number of electricity works and also controls the share capital of various supply companies, reports that the company's interests were not unaffected through the war. The heavy decline in the consumption of current in connection with the German works, which occurred in the initial months of the war, was subsequently followed by a great recovery, with the final result that at the close of the year 1914-15 the receipts in the case of some of the works exceeded those in the previous year. At the same time, the expenses increased everywhere owing to the advance in the cost of materials and of wages, and through the allowances granted to the families of the employés who were called to the Army. No definite information had been received for some time past in regard to the Russian interests—the Imatra Co. for the Production and Distribution of Electrical Energy, of Brussels, and the Moscow Electric Power Transmission Co. The accounts exhibit net profits of £45,000, as in 1913-14, and a dividend of 8 per cent. is proposed, as in the previous year.

Swiss Electrical Companies.

The working of the *Compagnie de l'Industrie Electrique et Mécanique, of Geneva*, was prejudicially affected in 1914-15 through the war and the general mobilisation. It is stated that the year's trading resulted in a loss, as was also the case in the preceding twelve months.

The *Watt, A.G. für Elektrische Unternehmungen, of Glarus*, which company is associated with the Zurich Bank for Electrical Undertakings, is interested in two Swiss electricity works and the Spanish Electricity Co., of Seville. Including the balance brought forward, the accounts for 1914-15 exhibit net profits amounting to £18,000, as compared with £26,000 in the previous year, and a dividend of 5 per cent. has been declared on the ordinary paid-up capital of £280,000, as contrasted with 6¼ per cent. in 1913-14.

The report of the *Elektrizitats Werk Lonza, of Basle*, states that the situation in 1914-15 developed beyond expectation, and the works were again set in operation after a temporary interruption in the early months of the war and were now fully occupied. An increase took place in the turnover in calcium carbide and in ferro-silicon, and in other iron alloys, and the artificial silicon-carbide and abrasite were also in demand. The market for cyanamide was specially animated owing to the scarcity of Chilean nitrate. After overcoming the difficulties caused through the war, the company at Waldshart was able to start working. The other undertakings in which the Lonza Co. is also financially interested suffered from the effects of the war at first, but an improvement subsequently took place. The accounts of the Lonza Co. indicate gross profits of £91,000, as contrasted with £80,000 in 1913-14, and net profits of £48,000, as against £42,000. It is intended to pay a dividend of 6 per cent. on the ordinary share capital of £480,000, as compared with 5 per cent. in 1913-14.

The *Columbus, A.G. für Elektrische Unternehmungen, of Glarus*, which is a financial company belonging to the Brown-Boveri group, and which controls the majority of the shares in the Compania Italo-Argentina de Electricidad, of Buenos

Aires, and the central stations at Dolores, Corrientes, and Pergamino, states that the war delayed the delivery of materials and caused difficulties in the sea transport, so that the extensions at the stations at Buenos Aires were retarded. The plant first completed there was of 18,000 KW., and the contracts concluded by the end of June, 1915, represented 15,000 KW., apart from the supply of energy to 2,000 public arc lamps. In addition, a contract had been entered into with the State for supply to the harbour works. The other three stations mentioned were also in course of satisfactory development. The accounts show gross profits of £59,000 for 1914-15, as compared with £8,000 in 1913-14, and net profits of £46,000, as against £5,700, and a dividend of 5 per cent. has been declared on the ordinary paid-up capital of £680,000, this rate contrasting with no distribution in 1913-14, which was the first complete business year.

Yorkshire (West Riding) Electric Tramways Co., Ltd.—The report for the year to December 31st, which is to be submitted at the annual meeting to-day, states that, after providing for all expenses, including repairs, maintenance, and debenture interest, the net balance is £29,310, plus £10,725 brought forward, making £40,035. A dividend of 6 per cent. per annum, less tax, on cumulative preference shares absorbs £12,028, and there is to be placed to depreciation, renewals, reserve fund in lieu of accident insurance, general reserve, etc., £12,962, carrying forward £15,045.

Western Union Telegraph Co.—The directors announce that the earnings report for the year ended December 31st last show revenue and income $52,356,286; expenses, including maintenance and reserve, $40,802,317; interest on bonds $1,335,588; net income, $10,218,381. The figures for the corresponding period in 1914 showed a net income of $5,371,395.—*Financial Times.*

East London Railway Co.—The number of passengers carried during 1915 was 8,497,284, against 6,172,121 in 1914.

Electrical Utilities Corporation, Ltd.—A quarterly dividend of 1¼ per cent. on the preferred stock has been declared for the quarter ended December 31st.

Brazilian Traction, Light and Power Co., Ltd.—The directors announce a dividend of 1 per cent. on the issued ordinary capital stock.

Sao Paulo Tramway, Light and Power Co., Ltd.—The directors have declared a dividend of 2½ per cent. on the issued common stock.

Montreal Light, Heat and Power Co., Ltd.—The directors have declared a dividend of 2½ per cent. for the quarter ending January 31st.

Rio de Janeiro Tramway, Light and Power Co., Ltd.—The directors announce a dividend of 1½ per cent. on the capital stock.

STOCKS AND SHARES.

TUESDAY EVENING.

Cheerfulness is the prevailing note in the Stock Exchange markets. There is a fair amount of business doing in most of the "live" sections; while in that for rubber shares, although the activity received a sharp check towards the end of last week, in consequence of a break in the price of the raw material, a recovery in the latter has given a gentle stimulus to fresh orders, and the share market is recovering again. More trade is passing, too, in Home Railway stocks, the nearness of the dividend declarations importing fresh interest. The news from Central and South America is not conducive to better prices in the securities connected with the various countries concerned.

The Home Railway revival started with improvement in some of the preferred stocks of the leading companies. As soon as buyers came in, it was obvious that proprietors of stock were by no means anxious to part with their holdings; and it required very little demand to hoist prices materially. The Underground issues have shared slightly in this better feeling throughout the market; but so far as "Mets." and Districts are concerned, both stocks are, of course, more or less speculative, and therefore swayed by the tendency which prevails in the Stock Exchange as a whole, rather than by rises in such sober-sided stocks as North-Westerns and the like. Underground Electrics are keeping steady, the income bonds and the "A" shares receiving most attention at the present time. As regards the £10 shares, the demand has slanted off to a noticeable extent; and less is heard now of the hopes current a fortnight ago as to the possible payment of a dividend on the shares before long. However, the pooling arrangement between the various Tube companies will soon be coming into operation, and expectation runs high of the savings, and the increased revenue, that they should bring in their train.

The District Railway, by the way, has found it necessary to overhaul its generous concessions to season-ticket holders, whereby it accepted a season ticket on deposit and added the full time to the next renewal of the ticket—an excellent arrangement from the holder's point of view, when he went away for summer or other holidays. Difficulties in the working of the system and the many abuses that have arisen are adduced by the company as the reasons for modifying the concession to the extent of making it obligatory upon the holder to deposit his ticket for a minimum period of 28 days, in respect of which he will be allowed 14 days on the next renewal taken up. This regulation is also to apply to season tickets between the District and its associated companies—namely, the London Electric, City & South London, Central London, Metropolitan and East London Railways.

The East London Railway report shows that 8½ million passengers were carried last year, an increase of 2,320,000 over 1914. The meeting will be held next Tuesday, January 25th. Bargains have been done in the ordinary stock this week at 3¾ and 3⅞.

News from Mexico is less indefinite, but less favourable, than had been hoped. Huerta, the strong man, is dead. He was looked upon as a useful second string if the Carranza *régime* were overthrown, either by diplomatic or military exigencies; indeed, many people in this country thought that Huerta would make a better President for the stormy State than Carranza. Various other generals are said to have relinquished this life in more or less summary fashion, and it seems as though conditions were once more drifting towards mere chaos. Therefore, Mexicans of all kinds are dull and depressed. Certain of the industrial bonds that were saleable are no longer so; and although the falls are comparatively small in the securities quoted overleaf, the present situation is that there are practically no buyers.

Brazil Tractions fell to 50, on a drop in the Brazilian exchange to 11½d.; but the price recovered 1¼, leaving it ¼ better on the week, thanks to the declaration of a dividend of 1 per cent. on the common shares. This was just 1 per cent. more than some of the pessimists had prophesied; but so long as the exchange question is so unsatisfactory, these apprehensions are bound to recur every quarter when the time for the dividend declaration draws near.

There is a little interest being taken in Canadian industrials, including those of the various power companies that are known to be engaged in munition work; and an unusually hopeful speech from the Chairman of the Bank of Montreal at last week's meeting has been of assistance to Dominion securities as a whole—more particularly those of the railroad and industrial concerns.

Anglo-Argentine Tramways are decidedly hard, and the First preference shares rose ½, possibly in sympathy with the strong efforts being made by American interests to acquire a controlling hand in Argentine railway companies. British Columbia preference is ex the dividend of 2½ points, but there is not much doing in the stocks of the company.

The intention of the Swiss Government to transform all its federal railways into an electrified system has been a matter of considerable comment. The estimated cost is put at twenty million pounds sterling—an amount which, before the European war educated us to think in millions, would have been regarded as an exceedingly large sum to raise. It is a matter for mild curiosity where the Swiss Government is going to get its money; because, unless it has a very substantial chest in reserve, it will have to go to the Western hemisphere, since the British Government is scarcely likely to permit investors in this country to use their money for such a project as that mentioned.

Falls of ¼ in Chelsea and in Metropolitan preference are the only changes in the list of home electricity shares. County of London keep steadily about 10, at which price, and a little over, there are buyers, whom holders are not anxious to supply, having regard to the proximity of the dividend announcement and the probability that it will be a satisfactory one. British Westinghouse preference keep very firm at their advanced price of 45s., and small improvements have taken place in both classes of Electric Construction shares.

The Telegraph market continues to attract investors, whose principal difficulty it is to secure the shares for which they have a fancy. Eastern Extensions, unchanged in price, are ex their dividend of 2s. 6d.; while Eastern Telegraph ordinary, also ex dividend, shows an actual rise of ¾. The latter is now on the same plane as Western Telegraph shares, which have risen to 12¾. Marconis are a better market, the parent shares improving in consequence of sharp rises in American Marconis and Canadians. The United States has been buying American Marconis freely, with the result that the price is up to 18s. 6d.; while Canadians have been bought with them, and, from 5s., went to 7s. 6d. in the course of a few days. Telegraph Constructions and India-Rubber shares both have rises of 10s. to their credit. Henleys for some time past have been difficult to pick up at all, but there has been rather more supply just lately; though when these shares are taken it will probably be as difficult as ever to get others.

Rubber slid from 4s. 3d. per lb. to 3s. 6d. per lb. in about a week, the drop unsettling the nerves of speculative investors who had been buying so freely while the raw material was on the rise. Business was brought to an abrupt halt, and there was a general turn round in prices. On rubber picking up a little, confidence followed suit; but there is nothing like the volume of trade being done that characterised the market a week or ten days ago. The iron and steel shares are mostly firm. Castner-Kellners at 3¾ are the fraction to the good. The armament market is also harder. In fact, the industrial departments all round show noteworthy strength.

SHARE LIST OF ELECTRICAL COMPANIES.

	Dividend, 1914.	Price Jan. 18, 1916.	Rise or fall this week.	Yield p.c.
HOME ELECTRICITY COMPANIES.				
Brompton Ordinary	10	7½	—	£6 18 4
do. 7 per cent. Pref.	7	7	—	5 0 0
Charing Cross Ordinary	5	3½	—	7 2 10
do. do. do. 4½ Pref.	4½	3½	—	6 0 0
do. do. City Pref.	4½	3 xd	—	7 10 0
do. 4 Deb.	4	7⅛	—	5 2 7
Chelsea	5	4	— ½	6 5 0
do. 4½ Deb.	4½	87	—	5 8 6
City of London	9	12½	—	7 7 8
do. do. 6 per cent. Pref.	6	11	—	5 9 1
do. do. 5 Deb.	5	98 xd	—	5 2 0
do. do. 4½ Deb.	4½	85 xd	—	5 6 0
County of London	7	10	—	7 0
do. do. 6 per cent. Pref.	6	10½	—	5 17 3
do. do. 1st Deb.	4½	85 xd	—	5 5 0
do. do. 2nd Deb.	4½	88	—	5 8 0
Kensington Ordinary	9	6	—	7 10 0
London Electric	4	1⅝	—	8 8 4
do. do. 6 per cent. Pref.	6	4½	—	7 1 2
do. do. 4 Deb.	4	75	—	5 4 0
Metropolitan	8½	2½	—	7 15 7
do. 4½ per cent. Pref.	4½	3	— ½	7 10 0
do. 4½ Deb.	4½	85	—	5 6 0
do. 3½ Deb.	3½	70	—	5 0 0
St. James' and Pall Mall	10	6	—	8 6 8
do. do. do. 7 per cent. Pref.	7	6	—	5 16 8
do. do. do. 3½ Deb.	3½	70 xd	—	5 0 0
South London	5	2⅝	—	7 5 6
South Metropolitan Pref.	7	1 7/16	—	6 14 0
Westminster Ordinary	9	6	—	7 10 0
do. 4½ Pref.	4½	4	—	5 12 6
TELEGRAPHS AND TELEPHONES				
Anglo-Am. Tel. Pref.	6	99½ xd	—	6 1 0
do. Def.	33/6	21⅛	—	7 15 9
Chile Telephone	8	6⅝	—	6 3 0
Cuba Sub. Ord.	5	8	—	6 6 0
do. Pref.	10	15	—	6 13 4
Eastern Extension	7	12½ xd	+ ⅛	*6 8 0
do. 4 Deb.	4	80	—	5 0 0
Eastern Tel. Ord.	7	127½ xd	+ ¾	*6 5 0
do. 3½ Pref.	3½	66	—	5 6 0
do. 4 Deb.	4	81	—	4 19 0
Globe Tel. and T. Ord.	6	10⅜	—	*6 12 2
do. Pref.	6	10½	—	5 17 1
Gt. Northern Tel.	22	83½	+ ½	6 11 4
Indo-European	13	49	+1	6 15 4
Marconi	5	1 15/16	+ 1/16	5 3 1
New York Tel. 4½	4½	100	—	4 9 1
Oriental Telephone Ord.	10	1⅞	—	5 6 8
do. Pref.	6	⅝	—	6 17 2
Tel. Egypt Deb.	4½	80	—	5 0 0
United R. Plate Tel.	8	6	—	*7 12 5
do. Pref.	5	4⅜	—	5 8 1
West India and Pan.	1	1/16	—	8 17 9
Western Telegraph	7	12⅜	+ ⅛	*6 5 0
do. 4 Deb.	4	79 xd	—	5 1 0
HOME RAILS.				
Central London, Ord. Assented	4	70	—	5 14 4
Metropolitan	1½	25½	—	4 18 0
do. District	Nil	16½	—	Nil
Underground Electric Ordinary	Nil	1/16	— 1/16	Nil
do do. "A"	Nil	6/6	—	Nil
do. do. Income	6	82	+ ½	*8 7 3
FOREIGN TRAMS, &c.				
Adelaide Sup. 6 per cent. Pref.	6	5	—	6 0 0
do 5 Deb.	5	95	—	5 5 0
Anglo-Arg. Trams, First Pref.	5½	4⅛	+ ⅛	6 13 6
do. 2nd Pref.	5½	3⅞	—	8 3 0
do. 4 Deb.	4	71½	—	5 12 0
do. 4½ Deb.	4½	77	—	5 17 0
do. 5 Deb.	5	8⅜	—	6 1 0
Brazil Tractions	3½	51½	+ ½	6 15 0
Bombay Electric Pref.	6	10½	—	5 17 1
do. 4½ Deb.	4½	85	—	5 3 0
British Columbia Elec. Rly. Ptce.	5	59 xd	—	8 9 6
do. do. Preferred	—	40	—	Nil
do. do. Deferred	—	35	—	Nil
do. do. Deb.	4½	64	—	6 12 10
Mexico Trams	Nil	39	−1	Nil
do. 5 per cent. Bonds	—	47	−2	Nil
do. 6 per cent. Bonds	—	40	−3	Nil
Mexican Light Common	Nil	29	—	Nil
do. Pref.	Nil	18	−2	Nil
do. 1st Bonds	—	47	—	—
MANUFACTURING COMPANIES.				
Babcock & Wilcox	14	2 7/16	—	5 15 0
British Aluminium Ord.	6	22/6	—	4 9 0
do. Pref.	6	18/-	—	6 13 4
British Insulated Ord.	15	10½	—	7 2 10
do. Pref.	6	5½	—	5 11 7
British Westinghouse Pref.	7½	45/-	—	6 13 4
do. 4 Deb.	4	69	—	5 14 10
do. 6 p. lien	6	101	—	5 19 0
Callenders	15	11½	—	6 11 4
do. 5 Pref.	5	4½	—	5 17 8
do. 4½ Deb.	4½	90	—	5 0 0
Castner-Kellner	20	7/8	+ ½	6 8 0
Edison & Swan, £3 pd.	Nil	8/6	−6d.	Nil
do. do. fully paid	Nil	1	—	Nil
do. do. 4 Deb.	4	60	—	6 13 4
do. do. 5 % Deb.	5	60	—	8 6 8
Electric Construction	6	14/6	+6d.	8 5 6
do. do. Pref.	7	1	+3d.	7 0 0
Gen. Elec. Pref.	6	9½	—	6 3 1
Henley	20	13½	—	*8 12 6
do. 4½ Pref.	4½	4½	—	5 6 0
do. 4½ Deb.	4½	99	—	4 17 9
India-Rubber	10	9½	+ ½	*12 19 0
Telegraph Con.	20	85	+ 9	*7 16 6

*Allowance made for dividends being paid free of income-tax.

Copper.—The largest purchase of copper ever made has recently been negotiated by the British Government in America. According to New York papers, the contract is for 135,000,000 lb. of the metal.—*Times.*

MARKET QUOTATIONS.

It should be remembered, in making use of the figures appearing in the following list, that in some cases the prices are only general, and they may vary according to quantities and other circumstances.

Wednesday, January 19th.

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	..	..
a " Nitric	"	..	..
a " Oxalic	per lb.	1/4	2d. inc.
a " Sulphuric	per cwt.	..	..
a Ammoniac Sal	"	..	..
a Ammonia, Muriate (large crystal)	per ton	£50	..
a Bleaching powder	"	..	..
a Bisulphide of Carbon	"	£23	..
a Borax	"	£25	..
a Copper Sulphate	"	£15	..
a Lead, Nitrate	"	..	..
a " White Sugar	"	..	..
a " Peroxide	"	..	..
a Methylated Spirit	per gal.	..	..
a Potassium, Bichromate, in casks	per lb.	..	..
a Potash, Caustic (88/90 %)	per ton	..	..
a " Chlorate	per lb.	1/8	3d. inc.
a " Perchlorate	"	1/6	..
a Potassium, Cyanide (98/100 %) (for mining purposes only)	"	Nom.	..
a Shellac	per cwt.	75/-	10/- inc.
a Sulphate of Magnesia	per ton	£18	..
a Sulphur, Sublimed Flowers	"	£11 10	..
a " Recovered	"	..	..
a " Lump	"	£8 10	..
a Soda, Caustic (white 70/72 %)	"	..	..
a " Chlorate	per lb.	1/4½	..
a " Crystals	per ton	60/-	..
a Sodium Bichromate, casks	per lb.	8½d.	..
METALS, &c.			
b Aluminium Ingots, in ton lots	per ton	..	..
b " Wire, in ton lots (1 to 14 S.W.G.)	"	..	..
b " Sheet, in ton lots	"	..	..
g Babbitt's metal ingots	"	..	..
c Brass (rolled metal 2" to 12" basis)	per lb.	1/2⅜ to 1/2⅝	¼d. inc.
c " Tubes (solid drawn)	"	1/3½ to 1/3¾	¼d. inc.
c " Wire, basis	"	1/2⅜ to 1/2½	¼d. inc.
c Copper Tubes (solid drawn)	"	1/1½ to 1/4	½d. inc.
g " Bars (best selected)	per ton	£125	£3 inc.
g " Sheet	"	£125	£6 inc.
g " Rod	"	£125	£6 inc.
d " (Electrolytic) Bars	"	£117	£8 10 inc.
d " " Sheets	"	£185	£8 10 inc.
d " " Rods	"	£124	£8 10 inc.
d " " H.C. Wire	per lb.	1/2½	½d. inc.
i Ebonite Rod	"	3/-	..
f " Sheet	"	2/6	..
g German Silver Wire	"	1 10	..
h Gutta-percha, fine	"	6/10	..
h India-rubber, Para fine	"	3/6½	6½d. dec.
j Iron Pig (Cleveland warrants)	per ton	79/-	..
j " Wire, galv. No. 8, P.O. qual.	"	£30	£2 inc.
g Lead, English Pig	"	£31	15/- dec.
g Mercury	per bot.	£16 15	..
c Mica (in original cases) small	per lb.	6d. to 3/-	..
c " " " medium	"	3/6 to 6/-	..
c " " " large	"	7/6 to 14/- & up.	..
c Nickel, sheet, wire, &c.	"	Nom.	..
g Phosphor Bronze, plain castings	"	..	..
g " " rolled bars & rods	"	..	..
g " " rolled strip & sheet	"	..	..
c Platinum	per oz.	210/-	..
d Silicium Bronze Wire	per lb.	1/3	..
r Steel, Magnet, in bars	per ton	£85	..
g Tin, Block (English)	"	£176 to £177	£2 inc.
m " Wire, Nos. 1 to 18	per lb.	2/8	..
g White Anti-friction Metals	per ton	..	..
k Zinc, Sh's (Vieille Montagne bnd.)	"	Nom.	..

Quotations supplied by—

a G. Boor & Co.
b The British Aluminium Co., Ltd.
c Thos. Bolton & Sons, Ltd.
d Frederick Smith & Co.
e F. Wiggins & Sons.
f India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.
g James & Shakspeare.
h Edward Till & Co.
i Bolling & Lowe.
k Morris Ashby, Ltd.
l Richard Johnson & Nephew, Ltd.
m P. Ormiston & Sons.
o Johnson, Matthey & Co., Ltd.
p
r W. F. Dennis & Co.

Coal Prices and Charges to Electricity Consumers.

—In the House of Commons, Mr. Will Thorne asked the President of the Board of Trade whether he was aware that the metropolitan borough of Islington had sent a circular to its electricity consumers, stating that in consequence of an advance of nearly 70 per cent. in coal prices the Council was compelled to increase the price of electricity commencing with the March quarter, and whether, seeing that the expectancy that charges for coal would be materially increased had not been realised, he would take further action in the matter. Mr. Pretyman, in reply, said he understood that the Borough Council of Islington had sent out such a circular. The electric lighting order under which the Council supplied electricity fixed the maximum charges which might be made to consumers. Electric lighting undertakers were acting within their statutory powers in varying their prices so long as the prescribed maximum was not exceeded. He presumed that the pit-mouth price of the coal the Council was buying complied with the provisions of the Price of Coal (Limitation) Act.

MUNICIPAL ELECTRICITY SUPPLY AT JOHANNESBURG.

BY R. TURNBULL MAWDESLEY.

THE vicissitudes of the municipal power plant at Johannesburg—from its inception in the pre-war days, down to the period of the gas engines whose absolute fiasco is still a green memory—need not be more than touched upon in this article.

In the early days, Johannesburg achieved an unenviable notoriety in the electrical world, for unreliability in its electric supply, which has taken some years to live down. This particular region of South Africa was then often very dark indeed. The lay Press used to wax mildly satirical on the subject of the trustworthiness of electric lighting and power; there were published rude caricatures of tramcars left forlorn upon the tracks, showing weeds growing up in abundance, between the track setts. In fact, ridicule was poured upon the scheme by all and sundry; and it is on record that ancient horse-drawn cabs used to follow cars bound for distant suburbs, secure in the knowledge that such cars would never reach their destinations.

In the days of the gas engines, it was no unknown thing for 20 or 30 natives to be "gassed" in one day; and old hands tell tales of the remarkable antics of white men, fresh from home, who, in some manner transcending the bounds of natural knowledge, became imbued with the indecorous spirit of the gas-engine room and behaved shamefully. One hears, too, of the seizure of "big-ends," and the indiscriminate scattering of white metal—what time the operating staff was outside in the fresh air, seeking recovery from the effects of the noxious fumes.

All that has been changed. Since the gas engines were scrapped, the municipal power station has gradually come into its own; and it is slowly but surely assuming its proper place in a town of the size and commercial importance of Johannesburg.

Johannesburg is situated on the southern slope of the Witwatersrand Range, and is about 6,000 ft. above sea level. Its population varies a great deal, but approximately there are now 130,000 whites and 150,000 coloured people. It is, historically, one of the most remarkable towns in the world—not excepting some of the mushroom towns which sprang up in America and Australia at the times of the gold rushes. In September, 1886, when the gold diggings were proclaimed by State President Kruger, the population of the township was only 50. To-day, notwithstanding the fact that it is, roughly, 1,000 miles by rail from Cape Town, and 600 miles from Durban, and connected to these coast towns for the most part by single-track railway, Johannesburg is a stately city. Its massive stone buildings, its wide roads, pavements, lighting and water, its tramways and means of communication, its police, with native police-"boys," to keep in order the hordes of semi-civilised Kaffirs; and, finally, its commercial and financial interests, are worthy of any European centre. Its association with the largest British power scheme will be known to all—though the Victoria Falls and Transvaal Power Co. have not, it is understood, any rights within the municipal area. The stability of the gold-mining industry is everywhere apparent, and not the least of Johannesburg's treasures is the South African School of Mines and Technology. Such is Johannesburg to-day.

It was perhaps unfortunate that some comprehensive scheme of power supply was not laid down by the Council of Johannesburg at first, as there could have been little doubt, even in the early days, that the future of the town was assured. It has been a gigantic and laborious task to undo the great amount of harm, caused—innocently enough, it may be—by the pioneers of the industry in South Africa.

Johannesburg was singularly unfortunate in having, first, an old-fashioned steam plant (belt-driven bipolar generators with horizontal engines); and secondly, in replacing these at great cost, by gas engines whose performance certainly did not come up to expectations, and whose failure left the city in a quandary.

The repeated failures of supply caused positive consternation in the city, and the subsequent law suits and recriminations are too well known to be recapitulated.

Gradually, however, a modern plant has been installed, whose reliability leaves little to be desired; its equipment has been brought up to date as quickly as circumstances have permitted, and to-day a "shut-down" is a distinct exception, rather that the previous rule.

The Gas, Electric Supply and Tramways Department of the Municipal Council of Johannesburg is at present managed by Prof. J. H. Dobson.

The principal power station is situated in President Street West, and is built upon a site adjacent to the original stations—the general offices, car-sheds and power station forming a compact group of buildings to the west of the city proper. There is a small gasworks to the north of the power station, which is managed by the same department; but little gas is used for illuminating purposes, the connections (numbering 470 at the end of November, 1914,) being mostly to hotels and restaurants, for cooking purposes. (During November, 1914, three million cubic ft. of gas were produced.)

The monopoly for lighting and power purposes is therefore held by the Electric Supply Department (within the municipal areas), and this is no mean consummation in the largest and most important city in Africa.

The original distributing system gave as much trouble as the generating plant, but this has been remedied as quickly as possible by the replacing of faulty feeders and distributors, as well as the laying of duplicate (in some cases quadruplicate) feeders. Considerable extensions in cable-laying have been, and are being, carried out, and the whole scheme is being brought up to modern ideas of maintenance and operation.

The present system, both as regards the generating plant and the distribution, is the outcome of a lengthy report, drawn up by Mr. Dobson in June, 1911, which contained an exhaustive survey of the original system—if system it could be called—and enumerated the alterations to be made both at the power station and on the lighting network, the object being to arrange for the installation of subterranean distribution, or link, chambers, at the busy centres, each with a duplicate feed, and the splitting up of sections by means of pillars above ground.

All this meant the removal of old and perished cable, disconnecting boxes, &c., and as a result the present system begins to stand out in strong contrast to that of 10 years ago.

Dealing first with the generating plant as at present installed at the principal power station, the capacity of steam-driven generators is 13,500 KW., made upas follows:—

No.	Capacity.	Make.	—	KW.
1	3,000 KW	Belliss - Lahmeyer turbo-alternator	2-phase	3,000
2	3,000 ,,	Belliss-Siemens turbo-alternators	2 phase	6,000
1	1,000 ,,	Belliss-E.C.C. reciprocating	2-phase	1,000
1	1,000 ,,	Belliss-Siemens ,,	D.C.	1,000
1	1,000 ,,	Belliss-Dick, Kerr ,,	D.C.	1,000
1	500 ,,	Belliss-Dick, Kerr ,,	D.C.	500
1	500 ,,	Belliss-E.C.C. ,,	D.C.	500
1	250 ,,	Allen-Mather & Platt	2-phase	250
1	250 ,,	Allen-Mather & Platt	D.C.	250
10	13,500 KW.	Total... ...	KW.	13,500

There is also installed in the main generating station some 4,000 KW. of motor-converting plant, the direct-current from which may be used either for D.C. lighting in the inner area of the town, or for traction purposes, as explained further on. The 250-KW. Allen reciprocators each have a two-phase alternator and two direct-current generators rigidly connected to the engine shafts in tandem, and it is possible by disconnecting the engine coupling-bolts, to use the A.C. and D.C. machines as motor-generators—the alternators being used as synchronous motors, to drive the D.C. machines, or *vice versâ*, whichever may be desired. The starting up, in this case, is accomplished by means of ordinary starting resistances in the D.C. armature circuits.

There are three distinct systems of supply from the generating station, the central parts of Johannesburg (or inne

area) being supplied, both for lighting and power, by a three-wire direct-current system at 230 and 460 volts.

The outlying suburbs are fed by single and two-phase feeders (the latter for power) at 3,000 volts, to step-down transformers (placed in subterranean chambers for the most part) and in kiosks, from which the supply is taken at 200 volts for domestic and street lighting.

There is also a third supply at 600 volts, direct current, for traction purposes—which may be derived from the Belliss D.C. reciprocators or from the motor converters.

In connection with the tramway scheme, one rotary sub-station at Jeppestown is at present in commission, for supplying the outlying and congested traction areas. Eventually three such sub-stations will be put into operation, each of which will contain two British Westinghouse rotary converters of 500-KW. capacity. These will receive two-phase current at 3,000 volts, 50 cycles, for conversion to direct current at 600 volts.

FIG. 1.—PART OF MAIN SWITCHBOARD WITH DESK-TYPE H.T. BOARD ON RIGHT.

The British Westinghouse Electric and Manufacturing Co., Ltd., have supplied the rotaries and transformers for these sub-stations, and the rotaries are of the so-called self-synchronising type.

Notwithstanding the three distinct systems of supply, the switchgear is not complicated, and a general view of the operating panels is given in fig. 1.

The desk type panels to the right control the A.C. supply at 3,000 volts, the alternator control switches and the synchronising gear being shown in the right background, while the single and two-phase feeder switch controls are shown in the right foreground. The 3,000-volt switches are of the oil-break remote-control type, mechanically operated by rods and handles, as shown—the oil switches themselves being contained in separate cubicles, built on a gallery below the operating platform. On this floor, shown in fig. 2, the regulating resistances are also placed, together with the auxiliary plant distributing board.

Referring to fig. 1, the main D.C. switchboard is shown on the left. In the middle portion of the board, four machine panels, for the Belliss direct-current sets, and four converter panels, controlling the direct current from the converters, are placed; the feeders branching to the left are three-wire lighting and power feeders (inner area) and those ranging off to the right are traction feeders. (There are, of course, two separate and distinct sets of bus-bars.)

Each D.C. machine has a main triple-pole change-over switch, the connections being such that, when it is placed in the upward position (*i.e.*, "on lighting") the machines run as shunt wound; and when it is in the downward position (*i.e.*, "on traction") the series field turns of the D.C. machines are cut in, and the machines run as compound wound. The whole of the D.C. steam-driven generators and the D.C. sides of the converters are slightly over-compounded, which has a dual effect on the converters, bringing the power factor to unity, and sometimes giving a leading current when the machines are doing their full rated load (on traction).

Fig. 3 shows a back view of the main direct-current switchboard, with positive traction bus-bar and feeder panels.

The Belliss-Siemens 1,000-KW. reciprocating set has a middle wire balancing connection. The converters each have a middle wire connection, to the star point of the rotor windings, which is, of course, earthed, and any out-of-balance current is distributed equally over the brush gear of the slip-rings.

The above-mentioned D.C. machine panels are each provided with two ammeters, a voltmeter, and a double-pole automatic circuit breaker—excepting the steam-driven non-balancing generator panels, which have only one ammeter. Plug sockets are provided on each machine panel for paralleling purposes.

The three-wire lighting feeders each have two ammeters, a triple-pole switch (the neutral connection of which is not used), and a double-pole automatic circuit breaker.

The traction feeders each have a single-pole switch or link, an ammeter, and a single-pole automatic circuit breaker. The double-pole lighting circuit breakers are interconnected mechanically, so that if one operates automatically, both circuit breakers open, leaving that particular feeder isolated. It should be mentioned that each lighting feeder feeds its own area, not being connected, normally, with other parts of the network.

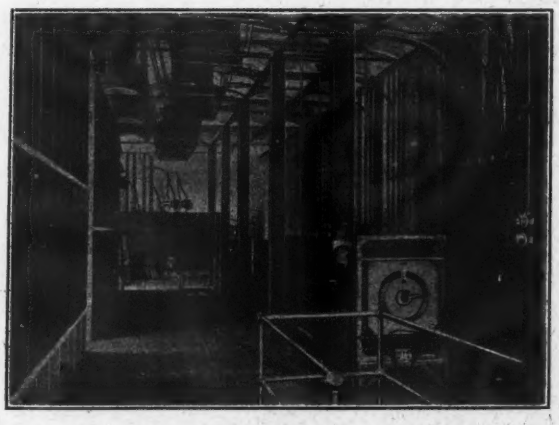


FIG. 2.—GALLERY UNDERNEATH MAIN SWITCHBOARD; OIL SWITCH CELLS ON LEFT.

Referring again to the A.C. control panels (fig. 1), the machine panels are each provided with two voltmeters and

two ammeters (one per phase), two watt-hour meters, two power-factor indicators, and the necessary plug sockets for synchronising. The oil switches are operated for overload by the instrument current transformers, and the switch handles each have the customary loose link, so that the switch cannot be held closed on short circuit. The single-phase feeders are so arranged that by the aid of oil-immersed selection links any feeder may be connected either to "A" phase or "B" phase, coloured signal lamps giving a corresponding indication on the desk panels.

The single and two-phase feeder switches are operated for overload by series transformers, the secondaries of which

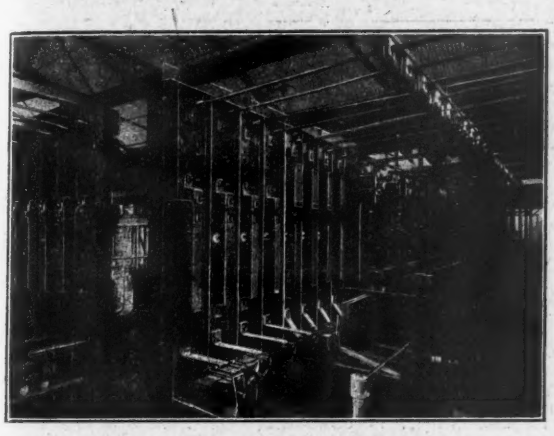


FIG. 3.—BACK VIEW OF PART OF MAIN SWITCHBOARD.

are connected in series with the ammeters and the switch trip-coils.

Duplicate synchronising gears are installed, one on each phase, and both the alternator oil switches and the feeder oil switches can be completely isolated by air-break links on either side of the switches.

The whole of the switchgear is by Messrs. Siemens Bros. Dynamo Works, Stafford. The original switchgear was placed on the engine-room floor level, but the existing Siemens switchgear is placed on a gallery at one end of the principal generating station.

(To be continued.)

NOTES ON ELECTRIC WELDING PRACTICE.

GREAT progress has been made in every system of electric welding during the twenty-five years or so which have elapsed since its practicability was first demonstrated, but the major portion of this progress has been accomplished during the last ten years, in which many manufacturers have concentrated their attention on the perfecting of special types of welding machines. Even to-day, and to a much greater extent in the past, trade reticence has had considerable effect in checking the extension of electric welding, for those firms who install electric welders find them such a "good thing" that they keep the fact to themselves—which is all right from their point of view, but none too pleasant for the electrical interests involved. However, that particular trouble lies chiefly in the past, and electric welders are now used in innumerable manufacturing processes, many of which would be commercially impracticable without electric welding.

The two broad classes into which electric welding applications may be divided are: (1) repair work and construction by building up—requiring skill; and (2) routine manufacture of parts in bulk—demanding, on commercial grounds, processes for which no special skill is necessary. There are innumerable manufactured parts now in daily use which could be made more cheaply from two or more pieces (instead of as a single casting, stamping or spun part), if only the component pieces could be joined cheaply and neatly. This is possible by electric welding, and the fact finds ever wider recognition and application.

Applicability.—It is undeniable that electric welding methods are by far the most widely applicable. Any "proposition" and any metal or pair of metals which can be welded by any other system of welding can be welded electrically but the converse is by no means true, for electric welding can do much that is impossible by other means. Primarily, electric welding alone can be reduced to a *machine process*, and this is of immense importance in manufacture; but naturally not all electric welding is mechanical. Judgment and skill are frequently required in its application, particularly where arc processes are concerned. One or other of the various possible methods of electric welding is applicable to practically every metal or combination of metals, whatever the mechanical form of the latter and, in particular, to many commonly employed metals which cannot be welded by any other means owing to their deterioration at high temperatures, rapid oxidisation, or some other unfavourable characteristic. Copper and aluminium, for instance, can be welded perfectly by electric butt or percussion welding. Wrought iron, mild steel, and even high carbon steel are regularly dealt with, whilst nickel steel is very easily welded electrically.

Composite welds, such as nickel to brass; brass to iron or steel or platinum; aluminium to brass or copper; platinum to iron or brass; German silver to wrought iron, copper or brass; and practically any grade of iron or steel to any other (*e.g.*, mild steel shanks to costly alloy steel tools or mild steel bars on to drop forgings)—all such welds and many others can be performed electrically and by no other means. As for the mechanical aspects of the work which can be performed, this ranges from plain "filling," butt, lap, scarf and angle welding to the most intricate combinations and multiplication of these operations. Bosses round holes may be formed by welding on rings after drilling or discs before drilling; all kinds of metal netting and lattice work can be performed in automatic electric welding machines; and tube seams can be closed, spokes attached to hubs, and all kinds of hardware and other sheet metal work built up by electric welding instead of soldering, brazing or riveting.

Strength of Weld.—Papers devoted specifically to consideration of the strength of electrically welded joints of all kinds have been read in considerable number, and it is neither practicable nor necessary to attempt to summarise the mass of data now available; but all data go to show that electric welds are invariably much stronger than hand welds (where the latter can be made), and generally stronger but never weaker than those made by gas flame methods. In the series of steels, the higher the percentage of carbon or other alloyed ingredient the greater the superiority of electrical over other welding methods.

It is an old precept that welded joints should be adopted very cautiously in working machinery and wherever failure would involve danger to life, the working stresses being made very low in such cases. This precept was and is a good one, but electric welding ensures such soundness in the weld itself and *so little affects metal on either side of the joint* that the union can be trusted in most responsible positions. For example, armature shafts, chain links, cables, and machine components are all regularly welded electrically. In short, electric welding has taken, and is quite competent to take, rank as a regular machine shop process in construction and repair. It is only necessary to recognise, as with any process, certain fundamental precautions in practice and design.

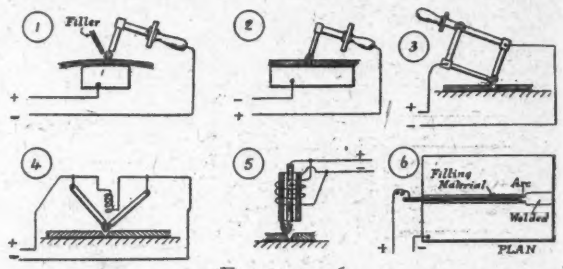
Methods.—All methods of electric welding depend fundamentally on the Joule effect, *i.e.*, on the conversion of electrical to thermal energy by resistance

interposed in the electric circuit. Nevertheless, the term resistance welding, of which there are several varieties, is generally applied to systems utilising contact resistance between the pieces joined. Arc-welding systems utilise the contact resistance between arc crater and incandescent vapour column, and the heat thus generated may be applied quite externally as regards the work, or the latter may be made one electrode so that heat is again, in a sense, due to contact resistance on the work, but with this *very important difference* that an *arc* being struck, there is a definite and very high temperature at the crater and heating is intense, more local and less under control than in ordinary resistance welding. When the arc is between two independent electrodes, manipulated as a sort of blowpipe, heating of the work is more under control as regards rate, distribution, and degree, if the worker has the requisite manipulative skill. The Hohe electrolytic process is a modification of butt-resistance welding, the contact resistance being between the electrolyte and the work, and due chiefly to a polarisation layer of hydrogen.

Arc Systems.—There are quite a number of electric welding systems coming under this heading, but all are "autogenous" in their action, *i.e.*, metal is actually melted to form a joint of cast structure. By feeding the arc with suitable materials it is possible to produce joints of widely varying compositions, but all arc welding processes are essentially processes for craftsmen. They require considerable skill to ensure satisfactory results, the difficulty being that the arc temperature is really considerably higher than desirable and incapable of control. On the other hand, arc welding alone is applicable to miscellaneous repair work and, being essentially a "filling" process, it is very useful in running-in molten metal of approximately any required composition to fill casting blowholes, contraction cracks and other flaws; to build up worn or broken parts and so forth.

An arc welding tool is compact, can be supplied efficiently through a relatively long cable, and can be applied with equal facility to any piece of work, whereas other systems require a more or less specially constructed machine. Also arc welding can often be applied to work which, by its form or dimensions, could not be dealt with by resistance welding. The strength of the original or adjoining section can be equalled or exceeded by building up metal, and it is remarkable what thin ware can be arc-welded satisfactorily by a skilled worker. At the same time, the chief utility of arc welding lies in railway shops, shipyards, rolling mills, foundries, tank and boiler shops, and general engineering works (particularly repair shops), whilst resistance and percussive welding are the systems *par excellence* for repetition and very light manufacture. If the operator is not skilled there is considerable risk of carbonising or introducing other foreign material in arc-welded joints; it is not easy to see precisely what is going on at the working point, and there is always the risk that the work will be burnt on the one hand or remain too cool to unite intimately with added metal, on the other hand.

In the Benardos arc system, fig. 1 (largely used to build up lugs and gear teeth, fill blowholes, joint tanks, pipe flanges and boiler fittings, etc.), an arc is struck between the work to be welded and a carbon (negative) electrode about 1 in. in diameter. The weld is fed from a stick of suitable metal held in the arc, and the latter may consume several hundred amperes at 80 volts or so. By making the work positive, the risk of carbon entering the weld is reduced, and the temperature attained is reduced, for a metal arc crater is cooler than a carbon crater. The functions of negative electrode and "filler" are combined in the Slavianoff system (fig. 2), which resembles the Benardos except that a metal electrode is used, generally $\frac{1}{8}$ to $\frac{1}{4}$ in. in diameter. The current consumption is seldom more than 100 amps., and often 20 amps., or less; and the voltage is much lower than for the carbon arc, say 25 to 35 volts. By making the metal electrode *positive*, molten metal is carried on to the work automatically, even when working on the underside of a surface. The metallic arc is very short ($\frac{1}{4}$ in. or less) and very sensitive to pressure variations, so that it is not very easy to manipulate, and it is hardly possible to run two in



FIGS. 1 TO 6.

parallel from one generator. The rather slower working and the complete elimination of carbon are valuable features, particularly in light work. To prevent splashing of molten metal from the feeder and protect it from possible oxidisation, the Kjellberg system uses a metal electrode surrounded by a casing which burns to form a crater and a flame arc; the voltage necessary is raised to 100 v., and from 100 to 200 amps. is consumed on boiler and marine repair work. The special electrode is connected to the positive main.

The Voltex, Zerener, and Coffin systems all use two electrodes producing a sort of electrical blowpipe, and permitting considerable control over the zone and degree of heating, which is specially valuable when working on thin sheet goods, welding straps and tube joints, etc. In the Voltex equipment (fig. 3), impregnated carbons set at right angles yield a long flame arc which consumes the carbon vapour and so protects the weld from carbon-hardening. The Zerener carbons (fig. 4) are in Vee-setting with an intermediate deflecting electromagnet; whilst the Coffin arrangement (fig. 5) is very ingenious in conception, and consists of concentric rod and tube electrodes and an electromagnet which causes the arc to run round the annular track provided for it, and so distributes the heating effect. The so-called Quazarc (Strohmenger-Slaughter) system (fig. 6) is semi-automatic in nature, and if carefully applied ensures a suitable quantity of "filling"-metal in the joint and correct speed of welding with no risk of overheating. A strip electrode of the filling-metal is lightly insulated (with a fluxing composition) and laid along the chamfer of the joint to be made; after once striking the arc at the end of this electrode, it runs along the latter as the metal melts, and $\frac{1}{2}$ to 1 ft. of joint is welded per minute. So long as the right size of electrode and the correct current are employed, and the edges are true and symmetrical, good working is secured with freedom from any difficulty in maintaining arc adjustment. The method is usefully applicable to tank and metal barrel manufacture as well as to heavier work.

(To be continued.)

THE DESIGN OF HIGH-PRESSURE DISTRIBUTION SYSTEMS.

THE paper by Mr. J. R. BEARD, which was abstracted in our issues of December 24th and 31st, 1915, and January 7th and 14th, 1916, was read and discussed at a meeting of the MANCHESTER LOCAL SECTION of the INSTITUTION OF ELECTRICAL ENGINEERS on December 14th, 1915.

Mr. S. L. PEARCE considered the subject of the paper of enormous importance. Engineers were well aware of the advantages of taking extra-high-tension supplies straight into

sub-stations on the consumers' premises, although to do this in the case of consumers having only 100 KW. demand (as suggested by the author) was perhaps open to question. He agreed that reactances were best used in connection with generators, not simply for the protection of any individual piece of switchgear, or even an individual generator, but chiefly for the purpose of preventing the derangement of the whole system in the event of a local fault developing, without dividing the system into a number of sections, or attempting to run the whole system in a most uneconomical way. Mr. Pearce exhibited a slide showing the lay-out of the main switchgear at the projected Barton station to illustrate his point. He agreed that it was impossible to estimate the severity of the fault which any particular switch might be called upon to deal with, and, whatever the capacity of the particular apparatus they might be controlling, the switches should be large enough to deal with any eventuality. Regarding the most economical section of mains, he exhibited a slide appertaining to 0.25 sq. in. 11,000-volt, 20,000-volt, and 30,000-volt cables, and giving figures showing the problem tackled from the point of view of dielectric losses. These were interesting as showing how the conclusions arrived at in favour of the 0.25 sq. in. 30,000-volt cable confirmed the conclusion of the author, who had dealt with the matter purely on the basis of $i^2 R$ losses. Figs. 5 and 6 showed that the higher the voltage the greater the maximum current per phase that could be carried, and the more nearly the cross sections of the cables (determined respectively by (*a*) consideration of economy on the one hand, and (*b*) safe carrying capacity on the other) approached one another. Fig. 6 would be of the greatest possible assistance to engineers laying out new systems or carrying out extensions to existing systems. The Manchester system was laid out about 14 years ago on the series-radial plan, and with the development of the area and industrial power load the number of sub-stations had increased to over 100. A rearrangement of the system became essential with a view to developing the useful employment of the copper laid, and also increasing the reliability of supply by the adoption of modern protective devices. Wherever possible existing mains were used to form ring mains with balanced-current protective devices, so that the copper would be more usefully employed, especially in outlying districts. The author was correct in stating that reverse power relays were unsatisfactory. His figures seemed to show an enormous difference in price between 20,000 and 30,000-volt switchgear; this did not agree with investigations made by the speaker some little time ago. In conclusion, Mr. Pearce said the trend of experience with modern high-pressure distribution stations, operating over wide areas and dealing with large and concentrated loads, seemed to point to the necessity first of all of choosing a distributing voltage even in excess of 20,000. It was well known that Manchester proposed to adopt 33,000 volts in connection with the Barton scheme. The second point was to employ the largest section of cable commercially possible. This would keep down the number of cables required for the system by the use of a balanced-current protective system, and, again, by adopting fewer cables the total number of switching points was reduced. Lastly, it was desirable to dispense with or limit as far as possible the number of step-down transformer points on the system, which, in other words, meant that the distinction between feeders and distributors was largely vanishing.

Mr. S. FERGUSON said that on a 6,000-volt system the capacity of the generating plant did not materially affect the initial short-circuit current flowing to a sub-station with an average-sized feeder exceeding one mile in length. The current was fixed by the impedance of the circuit, *i.e.*, the reactance of the generator windings and the resistance of the feeder, and in a typical case doubling the capacity of the plant only increased the short-circuit current by about 4 per cent. In both Manchester and Birmingham the sub-station oil switches had not been increased in size, although the capacity of the plant had increased enormously. Increased voltage (other things remaining constant) for the particular length of feeder mentioned made the short-circuit current more directly dependent upon the plant capacity, and it was advisable to bear in mind that the power delivered at a fault varied as the square of the voltage. Regarding interlocks, the most important on any cubicle was certainly the one dealing with incoming feeders. The attendant handling the switchgear could ensure the feeder being dead from the bus-bar side, but he could not answer for the man at the other side. Means should be provided for earthing the feeder or locking the feeder isolating switch chamber.

Dr. E. W. MARCHANT said that while a great deal of attention had been paid to the machinery of generating stations, far too little was given to distributing systems, which represented a large percentage of the capital outlay. Referring to the author's curves, and remarks concerning the most economical section of mains, he said that working out the relationship which existed by Kelvin's law of economy, it would be found that the economical current density in a cable was entirely dependent upon the cost of the cable, the resistance of the material of which the cable was made up, and the cost of energy per unit. Therefore, the economical current density was constant, and this result coincided with the author's tables; the curves between current and cross-section were straight lines, signifying that the current density was the same for all sizes of cable. An increase in voltage would cause the most economical current density for the cable also to increase. This was also shown by the author's tables, because the current density for a 20,000-volt cable was considerably greater than in the case of a 10,000-volt cable. It was clear from this result that if the working pressure was sufficiently increased and there was adequate insulation, a point would be reached where the economical current density would correspond with the heating limit. Kelvin's law, being founded on a basis of minimum total charge for energy distribution, was unsuitable for determining the most economical current for a cable already laid. The best basis for such a cable was minimum ratio of total cost of producing energy to revenue earned. As a rule, however, the difference was not very great.

Mr. G. HARLOW said the provision of an adequate size of primary winding on series transformers was very often overlooked, and within the past two years he had known at least seven cases of serious short circuits due to this trouble. An investigation of these had led to the adoption of primary windings at least equal in cross-section to the main to which they were connected. Regarding potential transformers on bus-bars, a protective oil switch, as suggested by the author, was absolutely necessary with 100,000-KW. main plant or 50,000-KW. in sub-stations. A breakdown at the transformer terminals was a fearful business, but if it occurred half way down the winding the impedance prevented much trouble. There were many stations where it was advantageous to use feeder reactances. Oil switches in sub-stations about one mile distant from the power station should be of the same capacity as the power-station switches. The speaker asked the author to state how much split conductor was laid on the North-East Coast system, and whether induction reactance was still used.

Mr. A. F. W. RICHARDS said that the curves showed that the cost of making ample provision for future requirements was almost negligible. Another outstanding point was that overhead mains at pressures up to 6,000 volts were not a paying proposition for transmitting power not exceeding 400 or 500 KW., assuming, of course, that there were not other considerations to be taken into account such as shortening route, etc.

Mr. S. J. WATSON spoke of the ease with which sub-stations could be set up when high-pressure distributing mains were adopted, whereas in the past in connection with D.C. systems low-pressure mains were frequently run out a considerable distance from the power station, with consequent difficulties in regulating and giving proper pressure to consumers. Whilst appreciating the author's efforts, he thought that in many cases the section of conductor for high-pressure systems was not worked out by the scientific methods set forth in the paper. Most systems, whether high or low-pressure, usually started in a small way, and when mains were laid there was very little indication where the load would come from. The practice had been to fix on a good-sized section of copper and lay cables in the directions where load seemed most promising. The generating station never by any chance became situated in the best position relative to the distributing system, and this fact appreciably affected not only the original lay-out but also new developments. In Bury the principal consumers were distributed in the form of a star. There was a fairly good demand adjacent to the main roads running out from the town, but between the tips of the star it was mostly waste land, and in an area of this kind a ring system could not be adopted on account of the cost and the large amount of idle cable. An important point was the small difference in cost (2½ to 5 per cent.), which enabled an engineer to increase the capacity of the cables by a very large percentage. A slight increase in copper was usually found to be a sound investment.

Mr. F. FERNIE asked whether the author excepted cables from the statement that no apparatus could be made immune from breakdown through external damage. It might be said that nobody could guard against damage to underground cables by workmen opening up the roads, but he knew of a case where the supply authorities received copies of all permits to open up roads, and by sending an inspector to point out the location of the cables damage of this nature was almost entirely eliminated. It had been reported that Newcastle proposed to use some 11,000-volt cables at 20,000 volts. Perhaps the author would state whether this had been done, or whether the 20,000-volt line of underground cable in fig. 6 would coincide with the 11,000-volt line. It was desired to know what minimum factor of safety the author considered permissible. Some of the 20,000-volt cables in the Newcastle district had a factor of safety of 7 to 8, whereas for 11,000 volts the figure was 10 to 15. By factor of safety was meant the ratio of the maximum stress at which the cable would break down to the maximum working stress. Referring again to fig. 6, some explanation was necessary to show why the inclination of the 20,000-volt line was different to that of the 11,000-volt line.

The AUTHOR, in reply, said that the reference to the use of high-pressure distribution for 100-KW. loads applied only to isolated loads, and in some cases it had been considered worth while to accept 50-KW. loads. Reactances on generating plant were very satisfactory on account of the perfection of modern automatic voltage regulation. The Ferranti-Waters and Callender-Waters systems were quite distinct, the former being a parallel feeder protection and the latter the split-conductor type, requiring a special cable. The Callender-Waters system was in actual use on the South-Western Railway at 3,000 volts. The cost of switchgear had not yet been dealt with in connection with the 30,000-volt gear, but the curve would probably continue upwards at about the same

slope on account of the spacing and thickness of insulation increasing more than proportionate to the voltage. No reference was made to the Ferranti-Waters system because it was not in actual use when the paper was written. An actual case worked out on this system showed the cost to be about 18 per cent. greater than any other system. This seemed inevitable with all systems using parallel feeders. In reply to Mr. Ferguson, 15,000 amperes at high voltage was as much as the best switch would do, and probably very much less would wreck many of the switches at present on the market. Reactances should not be necessary at the sub-stations, and only as a last resource on feeders. The breakdown of potential transformers was not appreciably affected by the size of the station, breakdowns taking place almost as readily in small stations as large ones. It should be a general rule never to put potential transformers direct on bus-bars, even in sub-stations. Generally speaking, they were not necessary in sub-stations, as the main transformer would meet all requirements. Regarding the North-East Coast system, there were 140 miles of split conductor, 385 miles Merz-Price protected cable, and a balance of 185 miles of overload cable, which represented some systems not yet linked up. Approximately, half the original overload protected Tyneside system had been changed over, and the remainder would no doubt be included in due course. Induction reactance had not been used on the split-conductor system for the past two years, but there was still a lot in commission and working perfectly satisfactorily. There was no trouble owing to extensions upsetting existing protective gear.

Discussion at Newcastle.

At a meeting of the Newcastle-on-Tyne Local Section of the Institution of Electrical Engineers on the 10th inst., Mr. J. R. Beard read his paper, of which an abstract was given in our issues of December 24th and 31st, 1915, and January 7th and 14th, 1916.

Mr. C. Vernier, in opening the discussion, said it was surprising, considering how much money had been put into high-pressure systems, that the subject had not been more adequately considered before. Referring to the question of mains, he said Mr. Beard dealt well with the question without deciding whether overhead or underground cables should be preferred. Generally speaking, one ran overhead mains where possible in the open country, and where the necessary wayleaves could be obtained, and it must be remembered that the wayleave question was always a difficult one. He did not think there was much to say against overhead lines, although they had their faults, and it was only a question of time before they got the overhead as perfect as the underground system. With regard to the annual charges for overhead and underground mains, he thought Mr. Beard was a little cautious in taking as a basis for his estimates the life of an underground cable at 22½ years and of overhead lines at 17½ years. The author would agree with him that the life was likely to be more than the time he had mentioned. The diagram showing the annual cost per mile for interest and depreciation rather favoured the underground system, for it was usually possible to get shorter routes for overhead lines than for cables. Referring to the section on the lay-out of the distribution system, he thought the paper was an attempt to prove the case of the interconnected system. To most of them there it did not require proving, but it might elsewhere; but the thorough manner in which Mr. Beard had gone into the matter ought to settle the question of the interconnected system *versus* other systems which were often laid down even now.

Mr. H. W. Clothier referred to the importance of switchgear as the protective system of the general scheme. For years they had been looking into the details of switchgear and overlooking the larger influence it had on the whole scheme. The paper touched on a very important point in connection with the strength of switchgear, and without dealing with the heavy short-circuit conditions, he might say there seemed to be no end to the development of that. He spoke of the difficulty that faced them owing to the growth of systems and of plant beyond what was anticipated when the switchgear was put in. As to the importance of guarding live apparatus, and the statement that it was a simple matter to interlock the guarding arrangements, he submitted that it was a brain-racking thing to interlock and screen all parts.

Mr. G. L. Porter and Mr. R. W. Gregory also spoke upon the interconnected system.

Mr. Beard, in the course of his reply, said that in that district overhead lines had been brought to a very high state of perfection, and he thought, as Mr. Vernier had said, that in the course of time the overhead lines would be almost as immune from breakdowns as were underground mains. As to switchgear, he pointed out the small proportion of cost compared with the whole—about 20 per cent. or 30 per cent. or less.

The Russian Electricity Tax.—Respecting the contemplated taxation of electrical current in Russia, it is stated in the *Narodie Vremya* that according to preliminary calculations of the Ministry of Finance, this particular tax is expected to yield about 17,500,000 roubles per annum.

THE ELECTRIC LOCOMOTIVE.

By F. W. CARTER, M.A., Assoc.M.Inst.C.E.

(*Abstract of paper read before the* Institution of Civil Engineers, *January 11th*, 1916.)

Electric locomotives, particularly those driven by motors of uniform torque, are capable of making better use of their adhesive weight than steam locomotives; with suitable provision for sanding the rails, the tractive effort may amount to a third of the weight on the driving-wheels, and the parts should be designed mechanically and electrically on the assumption that this limit is attainable. Locomotives driven by impulsive torque, such as those which employ the single-phase commutator motor, are naturally incapable of exerting so high a mean tractive effort, although the maximum stresses in the parts are likely to be higher.

Most locomotives, particularly those designed for goods service, are required at times to exert as great a tractive effort as the conditions allow, and the control is therefore usually devised in many steps, in order that the tractive effort in starting may, if necessary, be maintained very close to the limit of adhesion without overstepping it by the greatness of the peaks. The necessity of adapting the accelerating effort to the immediate requirements, and of being able on occasion to work close to the limit of adhesion, renders automatic methods of governing the acceleration unsuitable for general locomotive work, and the best practice favours methods in which the accelerating effort is under the immediate control of the driver.

Railway motors being usually designed with sufficient reserve to slip the driving-wheels without detriment to themselves, the weight that it is desirable to allow on the driving-wheels is limited by the strength of the draw-gear of coaches and wagons, which also limits the weight of train and the acceleration permissible with locomotive haul. The couplings used on English goods wagons, consisting of 1¼-in. iron chains, probably have an ultimate strength of the order of 60 or 70 tons, and it is not advisable to haul with a locomotive capable of giving a steady pull much in excess of, say, 15 tons. A locomotive having a weight on the driving-wheels of the order of 70 tons, capable of exerting an adhesive tractive effort in service of 17½ tons or more, is accordingly about as heavy as it is advisable to employ at the head of a train in England. As the permissible weight per axle is generally at least 18 tons, the English locomotive needs no more than four driving axles.

The electric locomotive, on account of its large haulage capacity as compared with its weight, shows to great advantage where opposing gradients are long and steep; the economies resulting from this consideration have, in fact, in a number of cases, proved the determining factor influencing the decision to electrify a main-line division. Where such conditions prevail, the use of the locomotive motors, acting regeneratively to restrict the speed of trains descending gradients and return a portion of their gravitational energy to the line for use in operating other trains, becomes feasible and attractive.

Electric locomotives admit of a primary division into two groups, namely, those in which the driving axles are actuated each by a separate motor, and those in which these axles are grouped and driven collectively, through the medium of side rods, by one or more motors. With a few exceptions these two groups correspond with the continuous-current and the alternating-current systems of operation respectively, and have their origin primarily in limitations of motor design. The continuous-current series motor in the rugged form needed for satisfactory locomotive driving is capable of developing large power in a confined space, and there is no appreciable sacrifice of economy or increase of maintenance cost arising from the use of motors of such size as is required to supply the power of a single axle. The single-phase commutator motor, however, is of necessity close to the limits of satisfactory design in many respects, due primarily to the difficulty of obtaining sufficiently good commutation under the conditions of service; and the imposition of space restrictions is felt as a serious obstacle to the attainment of satisfactory operation; the motive power is therefore preferably collected in large units located where restrictions are least onerous and continuous supervision is possible. These considerations, rather than the intrinsic merits of the side-rod design, explain the assiduous efforts that have been made to develop a satisfactory side-rod locomotive. Space restrictions also hamper the polyphase motor, though to a smaller extent than the single-phase commutator motor.

The commonest method for driving locomotive axles independently is through single reduction gearing, the motor being suspended horizontally between axle and transom, and the gearing being entirely at one end of the motor. The unsymmetrical drive has a tendency to wear the pinion-end bearing linings, and thus to throw the armature shaft slightly out of parallelism with the axle, and to increase the stresses at the motor end of the teeth. The gear face is usually 5 in. to 5½ in. wide, and increase in width beyond this does not increase the strength of the teeth in like proportion. It has, accordingly, become the practice, where powerful motors are used, to transmit the power through twin gears, which make better use of the material of the teeth.

Geared motors mounted above the axles and driving them

through quills are used on many American locomotives. Quill-driving fulfils a double purpose with regard to single-phase motors; it allows them to be supported elastically, and it helps to cushion the impulsive stresses of the driving forces which fall to zero or reverse twice in each period.

Another method extensively used for independent driving employs gearless motors having their armatures mounted concentrically with the axles. In the Grand Central Terminal locomotives of the New York Central and Hudson River Railroad the armature is built on the axle, and the field structure on the locomotive frame, the motor being bipolar, and so constructed that exact adjustment between armature and field in a vertical direction is unnecessary. The inelastically-supported weight on the driving axles in the case of the later types is less than 3 tons per axle, and is carried on 36-in. wheels. The gearless method of independent driving is particularly applicable to high-speed service, for which motors can readily be designed to make effective use of the material of construction.

In both geared and gearless types of independent drive, therefore, unless the expensive expedient of driving through a spring-supported quill is adopted, a certain amount of inelastically-carried weight is added to that of the wheels and axle. The determination of this in the case of gearless drives presents no difficulty, but the geared motor, in spite of its long standing, appears hitherto to have been wrongly treated.

Side-rod driving presents a much more difficult mechanical problem in the electrical locomotive than in the steam locomotive. In the electric side-rod locomotive the original drive is in the form of a uniform torque, and this cannot be converted to reciprocating drive without the introduction of large couples having transverse arms. The forces tending to produce distortion in the structure are accordingly considerable, but the permissible distortion, together with any inaccuracy of fitting, must nevertheless be no more than can be provided in the clearances between running surfaces. Careful design is therefore needed, and close adjustment of parts is necessary to avoid binding stresses; constant attention is, moreover,

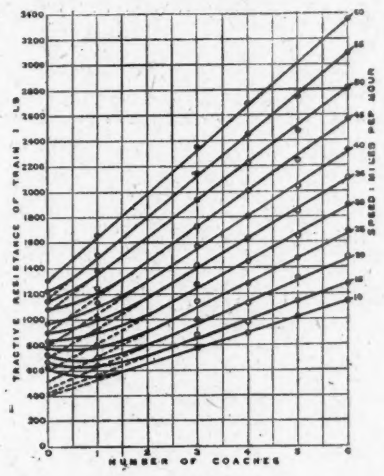


FIG. 1.

required to maintain the locomotive in satisfactory running order, to prevent knocking and the setting up of destructive vibrations.

Whilst locomotives driven by continuous torque are not likely to give trouble from fundamental causes, those driven by impulsive torque are apt at certain speeds to be set in resonant vibration by forces comparable in magnitude with the main driving forces, and it is doubtless to this that must be attributed the fracture of connecting-rods and shearing of crank-pins which has characterised this type of locomotive.

Even in locomotives driven by uniform torque there is possibility of resonant vibrations at certain speeds, due to higher harmonic components of driving force, and since these depend on the clearances and adjustments, the vibration may be more marked at some times than at others. In locomotives driven by impulsive torque, moreover, in addition to the possibility of resonant vibration arising from the fundamental forces, there is probability of such vibration being set up by some of the lower harmonic components of the driving force, and these are likely to be more violent than those set up in locomotives driven by continuous torque, which arise from higher harmonics. This is in accordance with experience; continuous-current and polyphase side-rod locomotives are apt to vibrate slightly at certain speeds, but single-phase side-rod locomotives vibrate much more violently and frequently. The Scotch yoke form of side-rod drive has long been in successful use on the three-phase lines of the Italian State Railways, 130 locomotives of the Giovi goods type alone having already been supplied. The use of the Scotch yoke form on the single-phase Lötschberg railway resulted in vibrations sufficient to fracture the yoke; in this case the trouble was mitigated, and the locomotives were rendered workable by transmitting the power of the motors through springs inserted between the gears and auxiliary shafts. Generally, however, destructive vibration has been characteristic of all single-phase side-rod locomotives employing commutator motors, and the combination of the periodic torque of constant frequency with the periodic change in the incidence of the driving forces of frequency depending on the speed appears to offer an adequate explanation of the phenomena observed; it is probable that single-phase rectifier locomotives driving through side-rods would exhibit similar characteristics, though to a smaller extent, since the application of power is somewhat impulsive in this case also.

Vibration under the control of the suspension springs may arise from want of balance in the rotating and reciprocating parts; since, however, all driving parts of an electric loco-

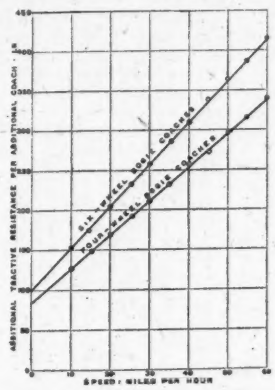


FIG. 2.

motive move in circles, dynamical balance is generally practicable.

The running of the locomotive on tilted rails and coned wheels causes it to progress with sinuous motion, and although the amplitude of this motion is restricted by the amount of flange clearance, its stability or instability has considerable influence on the performance of the locomotive, particularly with reference to the nosing tendency and the destructive track stresses resulting therefrom.

Factors making for stability are the haulage of a train, the elastic centring of guiding trucks, and to a smaller extent frictional resistances to the oscillation; the inertia of the structure, on the other hand, makes for instability.

In a locomotive fitted with guiding trucks centred by forces proportional to the transverse displacement, the motion is initially stable even when running without a train, and it is the task of the designer to render it stable within the whole range of operating speed and all conditions of operation.

The sinuous motion of the wheels also tends to set up a rolling oscillation of the locomotive, and when the speed is such that the period of this oscillation agrees with the natural period of rolling under the control of the suspension springs, violent swaying is likely to be experienced.

The subject of tractive resistance has received considerable attention in connection with steam trains, but few results derived from tests on electric trains are yet available. Of such tests, however, by far the most important and numerous were made by the General Electric Company in 1905 and 1906 on the Mohawk Division of the New York Central and Hudson River Railroad. Results of these tests have already been published in the usual form, in which the tractive

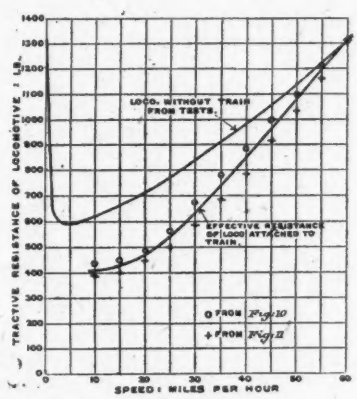

TRACTIVE RESISTANCE OF LOCOMOTIVE : LB.
LOCO. WITHOUT TRAIN FROM TESTS.
EFFECTIVE RESISTANCE OF LOCO ATTACHED TO TRAIN.
SPEED : MILES PER HOUR

FIG. 3.

resistance per ton of train is expressed in the form of a curve as a function of the speed, the curves for different lengths of train being adjusted to fit a certain type of formula. Re-examination of the original records, however, without bias towards a particular form of result, throws an interesting light on the mechanics of tractive resistance, which the authors of the tests in question appear to have overlooked.

The tests were made on trains of passenger coaches of two different varieties, which were not mixed in the tests; all the coaches were loaded with sand to considerably more than their normal passenger capacity. The locomotive weighed 90.7 tons.

The curves of fig. 1 give results of the tests, the ordinate representing the total tractive resistance of the train, including the locomotive, plotted against the number of coaches as abscissa for different constant speeds. It will be seen from these figures that each curve becomes substantially a straight line at its upper end, or that, after the first two or three coaches, the additional tractive resistance per additional coach at any speed becomes constant.

In fig. 2 the additional tractive resistance per additional coach is expressed as a function of the speed, and discloses the notable result that for both types of coach the increment of tractive resistance in question is substantially a straight-line function of the speed within the range of speed covered by the tets. This result was hardly to be expected, and other types of coach may well be found to show sensible deviation from a straight-line curve. However this may be, the curve of increment of tractive resistance per additional coach affords valuable data which might with advantage be determined for the principal types of coach in use on a railway.

The tractive resistance of the locomotive apart from the train is not really of much importance, since the condition is not a service one. It is apparent, however, from fig. 1, that the train has a steadying effect on the running of the locomotive, particularly at low speed; in fact, in some cases the total tractive resistance of the locomotive and one coach is seen to be actually less than that of the locomotive alone. If the straight-line portion of a tractive-resistance curve of fig. 1 be extended backwards, as shown in broken lines, to the line of no coaches, the resistance thus indicated may be regarded as the effective resistance of the locomotive, and this is really more valuable than the results of direct test on the locomotive running alone, since it corresponds with service conditions.

Fig. 3 gives the effective locomotive resistance derived from fig. 1, and the resistance obtained by direct test of the locomotive running without a train.

The curves of effective tractive resistance of locomotive and additional tractive resistance per coach furnish the means of determining the tractive resistance of any train composed of the given locomotive and coaches, and the confidence that may legitimately be felt in such determination is of a higher order than can be derived from the data usually employed in this connection.

NEW PATENTS APPLIED FOR, 1916.

(NOT YET PUBLISHED).

Compiled expressly for this journal by Messrs. W. P. Thompson & Co., Electrical Patent Agents, 285, High Holborn, London, W.C., and at Liverpool and Bradford.

339. "Radiotelegraphy apparatus." A. Arbib & W. J. Mellersh-Jackson. January 7th.

16. "Electric switches and fuse switches." H. H. Berry. January 3rd.

309. "Apparatus and process for separating argon." British Thomson-Houston Co., Ltd. (General Electric Co., U.S.A.). January 7th.

198. "Starting mechanism for automobiles." British Westinghouse Electric & Manufacturing Co. January 5th.

133. "Temperature booster for hot-water heating systems." W. E. Clark. January 4th.

43. "Electrolytic process for the manufacture of metallic wire and strip." S. O. Cowper-Coles. January 3rd.

44. "Process for the production of copper driving bands." S. O. Cowper-Coles. January 3rd.

385. "Electric indicators." Edison & Swan United Electric Light Co. and R. E. H. Lovelace. January 8th

54. "Electrical range finders." Ferranti, Ltd., & C. Rey & P. Testard. January 3rd.

224. "Driving and controlling dynamo-electric generators." J. Firth and W. F. W. Rhodes. January 6th.

70. "Electric controller, particularly for use with electrically-propelled vehicles." J. E. Hamilton. January 3rd.

149. "Suspenders for electric cables, etc." P. Huntingdon. January 5th.

245. "Receivers for wireless signals." Marconi's Wireless Telegraph Co. and G. M. Wright. January 6th.

246. "Receivers for wireless signals." Marconi's Wireless Telegraph Co. and G. M. Wright. January 6th.

247. "Receivers for wireless signals." Marconi's Wireless Telegraph Co. and G. M. Wright. January 6th.

346. "Electrolytic deposition of a cobalt-silver alloy." P. Marino. January 7th.

235. "Guide for connecting trolley wheels to overhead wires." A. S. Mizen. January 6th.

203. "Casings for electric wires." A. K. Modi. January 5th.

155. "Electrical signalling apparatus, specially applicable for military and training purposes." E. G. Pulford. January 5th.

19. "Apparatus for undercutting the insulation between the commutator segments of electrical motors and dynamos." A. T. Robinson. January 3rd.

250. "Fuses for protecting electric circuits." A. Schaanning & S. A. Stigant. January 6th.

334. "Order telegraphs, etc." L. Schor. January 7th.

139. "Transmitters, microphones, relays, etc., for telephonic and similar purposes." H. Smith. January 4th.

369. "Extra-high-tension isolating-link phase indicator." V. H. Tregoning. January 7th.

184. "Electric incandescent lamps, filaments therefor, and manufacture thereof." E. Wechsler. January 5th.

177. "Arc lamps." G. Westercamp. January 5th.

179. "Means for propelling a load along a cable." G. Westercamp. January 5th.

288. "Electric lighting means." R. S. Woods. January 7th.

358. "Electric lighting system or circuits." H. Wrigley. January 8th.

PUBLISHED SPECIFICATIONS.

1914.

24,121. Electric Illumination Systems, more particularly for Automobile Vehicles. L. Renault. December 15th. (April 3rd, 1914.)

24,231. Receiving System for Continuous Electric Waves. E. H. Armstrong. December 17th. (December 18th, 1913.)

24,235. Manufacture of Rubber-covered Electric Conductors. W. Geipel. December 17th.

24,502. Vapour Electric Lamps. F. Bousson. December 22nd. (Convention date not granted.)

24,746. Telegraphic Transmitting Apparatus. S. Wechsler. December 29th.

1915.

647. Electric Signalling. F. G. Cole. January 15th.

1,090. Electrical Terminals. Sterling Telephone & Electric Co. and T. D. Ward-Miller. January 22nd.

2,014. Electric Control Apparatus. A. H. Curtis & Igranic Electric Co., Ltd. February 8th.

2,619. Electric Starters for Internal-combustion Engines. A. H. Midgley and C. A. Vandervell. February 18th.

3,261. Electric Light Fittings. L. A. Maurice (Executrix of G. Maurice, deceased) and F. T. Cash. March 1st.

4,045. Electrical Switches. A. P. Lundberg, G. C. Lundberg, P. A. Lundberg, and G. Pegg. March 15th.

5,727. Means for Attaching Electric Cables or Conduits to Switches and the like. G. Ellison and J. Anderson. April 16th.

5,879. Combined Electric Switch and Wall Plug. W. H. Sturge. April 20th.

5,889. Electric Heating Element. Cable Accessories Co., Ltd., & F. H. Reeves. April 20th.

6,093. Lead-jointing Sleeve for Electric Joints. C. J. Beaver & E. A. Claremont. April 23rd.

13,051. Replaceable Electrical Safety Fuses. W. J. John. September 13th.

An Exhibition in Spain.—The world-war notwithstanding, it is intended in Spain to hold an international exhibition of Spanish electrical and general industries. At a conference held on December 30th, the plans were discussed; the cost of the exhibition was stated to be estimated at 40 millions of pesetas and the receipts at 45 millions. A "Festival of the Spanish Race" will be a feature of the exhibition, and it is expected that the Presidents of the Spanish South American States will assist King Alfonso at the opening ceremony.

Factory Property in 1915.—Messrs. Leopold Farmer & Sons in their report on factory and commercial property sales in 1915, state that in their experience the sales and letting of factory property, wharves, land, &c., showed far better results than was the case in 1914. "This result is in a large measure due to the war, which has produced a great demand for factories and commercial property of all descriptions. As we anticipated in the early stages of the conflict a demand was created for factories, due primarily to the requirements of the Government for the manufacture of the necessary war equipment for our Fighting Forces, and, secondly, for the manufacture in this country of goods previously imported. . . . The nation's immediate wants have necessarily demanded extra pressure of manufacture which created a necessity for the opening up of factories, as well as the extension of present ones, to cope with the enormous requirements of the country. We have disposed of a large number of factories, with and without plant and machinery, at figures running into many thousands of pounds, and an unprecedented demand still exists for properties of all kinds. Premises that previously to the war had failed to find tenants for years have been rapidly taken up, owners in many cases having obtained, through competition, increased prices. It is interesting to record on analysing the demand for factories that many have been disposed of to the Government, Government contractors in all branches of manufacture, English firms starting to manufacture goods previously imported (now barred through the war), and Belgian manufacturers who largely exported goods to this country, but are prevented from doing so now owing to their works having been destroyed by the Germans."

Ball-Bearings on Railway Rolling Stock.—In 1910 experiments were made on the Montreux-Oberland electric railway with the use of ball-bearings on the rolling stock, and the results were so successful that now all new passenger motor-coaches and trailers and a proportion of the goods wagons are fitted with them. Their use has not been confined to the axles, as they have been found excellent for the bogie slides, easing the motion round curves. The latest step is to fit ball-bearings on the electric motors, which are of 114 H.P. each and run at 1,660 R.P.M. at 45 km. (28 miles) per hour, and the result has been entirely satisfactory. Experiments with dynamometers showed that with ordinary bearings the tractive resistance was 5·3 kg. per ton, and with ball-bearings 2·3 kg. per ton; the latter require lubrication only once in six months in place of every 10 or 15 days, and last for 10 to 15 years instead of about two years.